125(3656)

Proceedings of the United States National Museum

SMITHSONIAN INSTITUTION • WASHINGTON, D.C.

Volume 125 1968 Number 3656

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By Alan G. Lewis

SMITHSONIAN INSTITUTION PRESS

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Copepod Crustaceans Parasitic on Fishes of Eniwetok Atoll [1]

By Alan G. Lewis [2]

Copepod parasites of fishes of Eniwetok Atoll, one of the Marshall Islands, have not been previously studied. The only reference dealing with parasitic copepods from this general region of the Pacific is that of Heegaard (1943) concerning some caligids from the Gilbert Islands. Both Heegaard (1940, 1962) and Kabata (1964, et al.), however, have described copepods from fishes from the neighboring Australian region, some of which are also found on fishes from Eniwetok Atoll, and Hewitt (1963, et al.) and Thomson (1889) have described copepods from fishes of New Zealand. These studies, as well as those of Lewis (1964a, et al.) concerning copepods from Hawaiian fishes, cover most of the named species although some of them have previously been described from other areas, primarily the western Pacific and the Indian Ocean.

The study herein reported is based on two collections made by the author during the summers of 1959 and 1961. He is indebted to the U.S. Atomic Energy Commission for the use of the facilities at the Eniwetok Marine Biological Laboratory. He is also grateful for the

[1] This study was supported by a grant (GB–3932) from the National Science Foundation.

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assistance given to him by James Coatsworth, John Shoup, and David Au, who were serving as research assistants at the Eniwetok Marine Biological Laboratory during the periods when the collections were made. Finally, the author appreciates the help given to him by members of the Division of Crustacea of the Smithsonian Institution during the time of final examination of the specimens in the collections.

METHODS.—The external surface, gill cavities, buccal cavity, and nasal cavities of the hosts were examined for parasitic copepods. Copepods collected were killed and preserved in 95 percent ethyl alcohol. Specimens to be drawn or dissected were placed in 85 percent lactic acid to clear and soften them, stained with Chlorazol Black E dissolved in 85 percent lactic acid, and then placed in benzyl alcohol for final clearing and for dissection and drawing.

Drawings of the entire animal were made from specimens placed in benzyl alcohol and covered with a cover slip, supported so that the shape of the organism was not distorted. A camera lucida was used in making the drawings. The appendages and processes were

TABLE 1.—*Armature of hypothetical thoracic leg shown in figure 1*

Leg	Surface	Interpodal Plate	Protopodite		Exopodite			Endopodite		
			1	2	1	2	3	1	2	3
	Outer		m,h,rh,r		r,D,d,dh	H	fH,Z,mH, dmH.	C	c	mp′,mp,Q
	Inner		a,sss,s, dm,fm		c,fm,H	c,P	Cl,cl,dH	P	p,p′	2P′,Q′

drawn in situ or were removed and mounted in either Hoyer's mounting medium or a 1:1 mixture of Turtox's CMC–10 and CMC–S. Measurements were made with an ocular micrometer on specimens softened in lactic acid and held loosely in place by a cover slip supported by spacers.

In the figures, the ♀ and ♂ signs are used separately under each drawing to indicate a difference between the appendage or body part of the female and that of the male. The symbols are used together (♀ ♂) to indicate the similarity of the appendage or body part in both sexes. In the latter case the sex of the specimen from which the drawing was made is indicated by a line under the appropriate symbol.

TERMINOLOGY.—The term "cephalothorax" is used to indicate a condition in which one or more of the thoracic segments are fused with the cephalon. The maxilliped-bearing segment is considered as the first thoracic segment. The term "pedigerous segment" is used to indicate a leg-bearing thoracic segment, while the terms "free thoracic

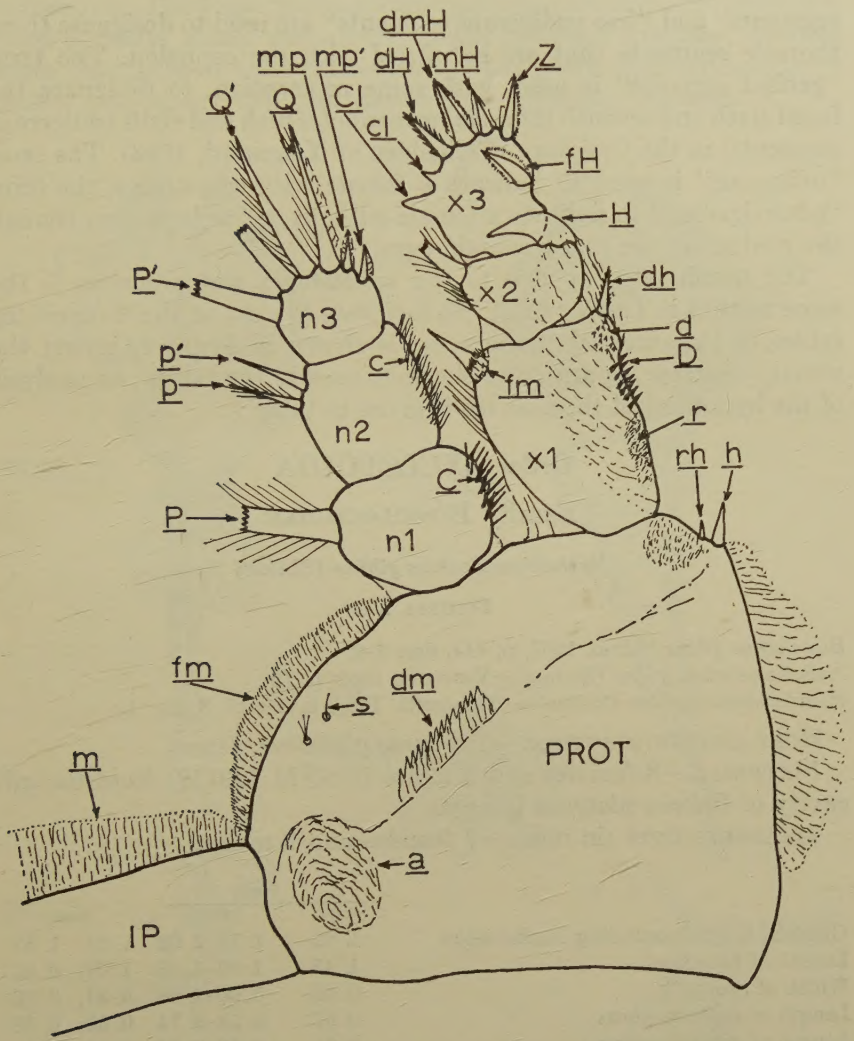


FIGURE 1.—Hypothetical thoracic leg showing the various armament components (a=adhesion pad; C=large plumosities; c=small plumosities; Cl=large spikelike extension of segment; cl=small spikelike extension of segment; D=large denticulations; d=small denticulations; dH=large spine with denticulations; dh=small spine with denticulations; dm=denticulated membrane; dmH=large spine with denticulated membrane or membranes; fH=large spine with frilled membrane or membranes; fm=frilled membrane; H=large spine; h=small spine; IP=interpodal plate; m=membrane; mH=large spine with simple membrane or membranes; mp=setule with membrane on both sides; mp'=setule with membrane on one side, naked on other; n 1,2,3=endopodite segments one, two, three; P=plumose seta; P'=naked seta; PROT=protopodite; p=plumose setule; p'=naked setule; Q=seta with plumosities on one side, membrane on other; Q'=seta with plumosities on one side, naked on other; r=numerous minute projections giving rugose appearance; rh=spinule; s=hairlike process; x 1,2,3=exopodite segments one, two, three; Z=spine with frilled membrane on one side, simple membrane on other).

segments" and "free pedigerous segments" are used to designate those thoracic segments that are not fused with the cephalon. The term "genital segment" is used, with some reservation, to designate the fused sixth and seventh thoracic segments (=fifth and sixth pedigerous segments) in the Caligidea (Caligoidea of Yamaguti, 1963). The term "ovigerous" is used to indicate a female with egg strings, the term "nonovigerous" to indicate a female without egg strings even though the genital segment may contain eggs.

The terminology applied to the appendages and processes is the same as that in Lewis (1967). To facilitate the use of the thoracic leg tables, a hypothetical thoracic leg is shown in figure 1, giving the various thoracic leg armature elements used in the tables; an analysis of the hypothetical thoracic leg is given in table 1.

Order CYCLOPOIDA

Family BOMOLOCHIDAE

Nothobomolochus gibber (Shiino)

FIGURES 2–4

Bomolochus gibber Shiino, 1957, p. 411, figs. 1–2.
Nothobomolochus gibber (Shiino).—Vervoort, 1962, p. 70.
Pseudartacolax gibber (Shiino).—Yamaguti, 1963, p. 14, pl. 8, fig. 1.

HOST AND DISTRIBUTION.—*Tylosurus giganteus*, Japan.

MATERIAL.—8 females and 2 males (USNM 120739) from the gill cavity of *Belones platyura* Bennett.

MEASUREMENTS (in mm).—7 females and 2 males:

	female		*male*	
	mean	*(range)*		
Greatest length, excluding caudal setae	1. 82	1. 71–2. 02	1. 57,	1. 58
Length of prosome	1. 15	1. 03–1. 30	1. 01,	0. 95
Width of prosome	0. 98	0. 90–1. 08	0. 81,	0. 86
Length of cephalothorax	0. 67	0. 58–0. 74	0. 50,	0. 58
Length of genital segment	0. 21	0. 18–0. 25	0. 16,	0. 14
Width of genital segment	0. 29	0. 22–0. 36	0. 29,	0. 25
Length of egg sac (6 sacs)	1. 23	0. 99–1. 37		

DESCRIPTION.—Cephalothorax of ovigerous female (fig. 2*a*) wider than long, consisting of cephalon and first 2 thoracic segments. Anterior end of cephalothorax forming 2 bilobed projections separated by rounded dorsal and bilobed ventral median surfaces. Lateral margins irregular, lateral posterior margins lobate. Dorsal cephalothoracic surface arched, with anterior median fissure. Width of free second pedigerous segment slightly more than two and one-half times the length, slightly more than half the width of cephalothorax. Lateral surfaces winglike, extending slightly past base of second

thoracic leg. Third and fourth pedigerous segments separable ventrally, fused dorsally; dorsal surface topshaped although irregular, greatest width slightly more than that of second pedigerous segment; posterior surface overlapping fifth pedigerous (first urosomal) segment.

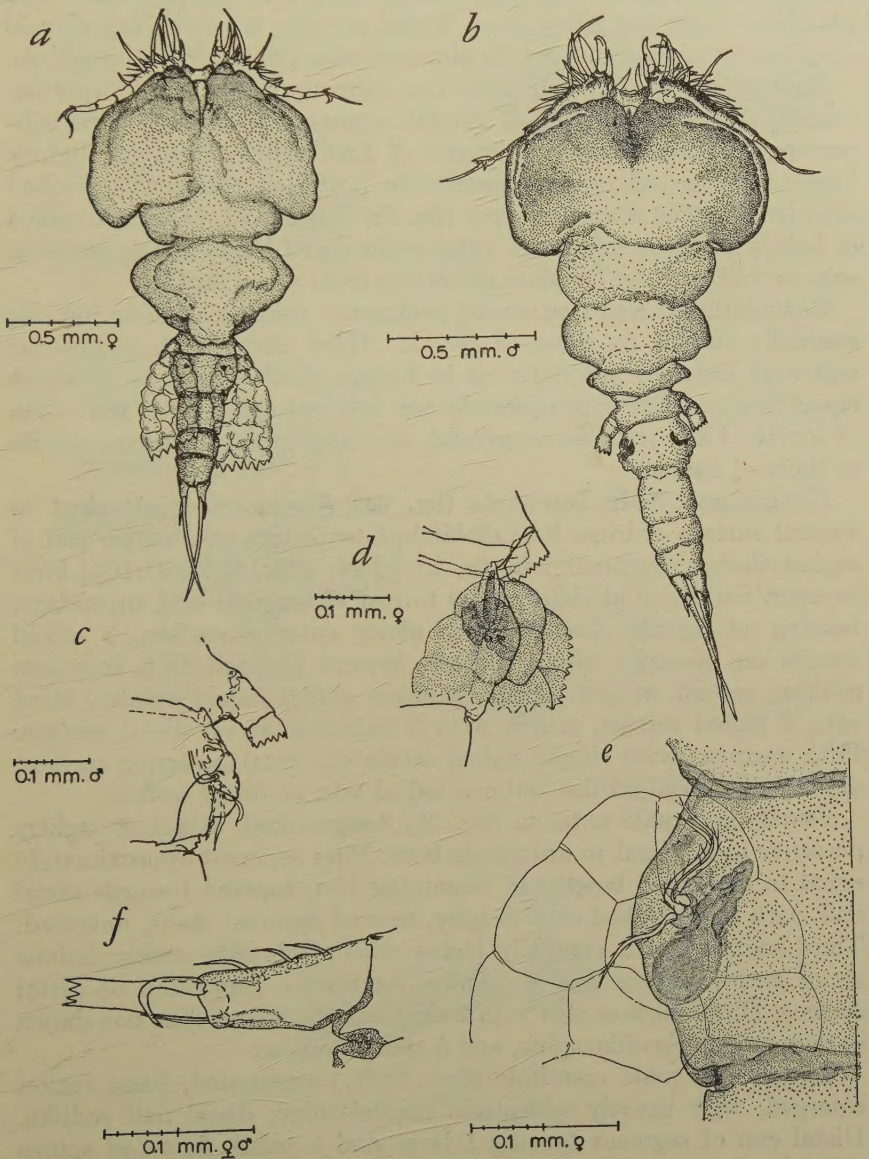


FIGURE 2.—*Nothobomolochus gibber* (Shiino, 1957): *a*, female dorsal view; *b*, male, dorsal view; *c*, male, genital segment, ventral view; *d*, female, genital segment and part of egg string, ventral view; *e*, same, dorsal view; *f*, caudal ramus, ventral view.

Female fifth pedigerous segment slightly less than half the width of third and fourth, widest medially, in region of leg attachment. Genital segment (figs. 2*d*, *e*) broadest medially, tapered to posterior and anterior ends. Oviducal openings situated on lateral dorsal surface, region around openings ornamented with heavily sclerotized platelets. Sixth legs situated on dorsal surface, adjacent to oviducal openings, consisting of 3 lightly plumose setae originating from nodule.

First segment of female abdomen subrectangular, length approximately three-fourths that of genital segment. Second segment subrectangular, four-fifths the length of first. Third segment slightly longer than second, tapered posteriorly, posterior surface with bilobed anal indentation. Caudal ramus (fig. 2*f*) subconical, bearing 3 naked or lightly plumose setules on outer surface and large, lightly plumose seta as well as 2 lightly plumose setules from distal surface.

Cephalothorax and free second pedigerous segment of male (fig. 2*b*) generally similar to those of female. Third and fourth pedigerous segments distinct, not fused as in female. Both segments of about equal length, third approximately one and one-third times the width of fourth. Fifth pedigerous, genital, and abdominal segments similar to those of female.

Female and male antennule (fig. 3*a*) 5-segmented, attached to ventral surface of inner lobe of bilobed projection at anterior end of cephalothorax. Segment lengths, in micra, 205:135:90:95:100. First segment with base at right angles to rest of segment and appendage, bearing 14 lightly plumose setae along anterior surface, 3 naked setules on posterior distal surface. Second through fifth segments rodlike; second with 6 lightly plumose and 3 naked setules, third with 3 naked setules, fourth with 2 naked setae on distal surface. Fifth segment with single, naked setule on distal posterior surface, also with 3 naked setules and one naked seta on distal surface.

Female and male antenna (fig. 3*b*) 3-segmented, attached slightly posterior and lateral to antennule base. First segment approximately equal to combined lengths of remaining two, tapered towards distal end, with single naked seta distally. Second segment short, unarmed. Third segment with ventrally facing rows of clawlike denticulations along entire surface and extending on toelike projection of distal surface. Distal surface also with 2 denticulated spines (one not shown in figure), one clawlike spine, and 5 clawlike setae.

Female and male mandible (figs. 3*c*,*d*) 1-segmented, basal region enlarged, with heavily sclerotized medial ridge; distal half rodlike. Distal end of segment bearing 1 large and 1 small, flattened spines serrated along anterior margins. Maxillule (fig. 3*c*) nodular, situated immediately posterior to mandible base, with 2 plumose setae and 2 plumose setules. Maxilla (figs. 3*c*,*e*) 2-segmented, proximal segment

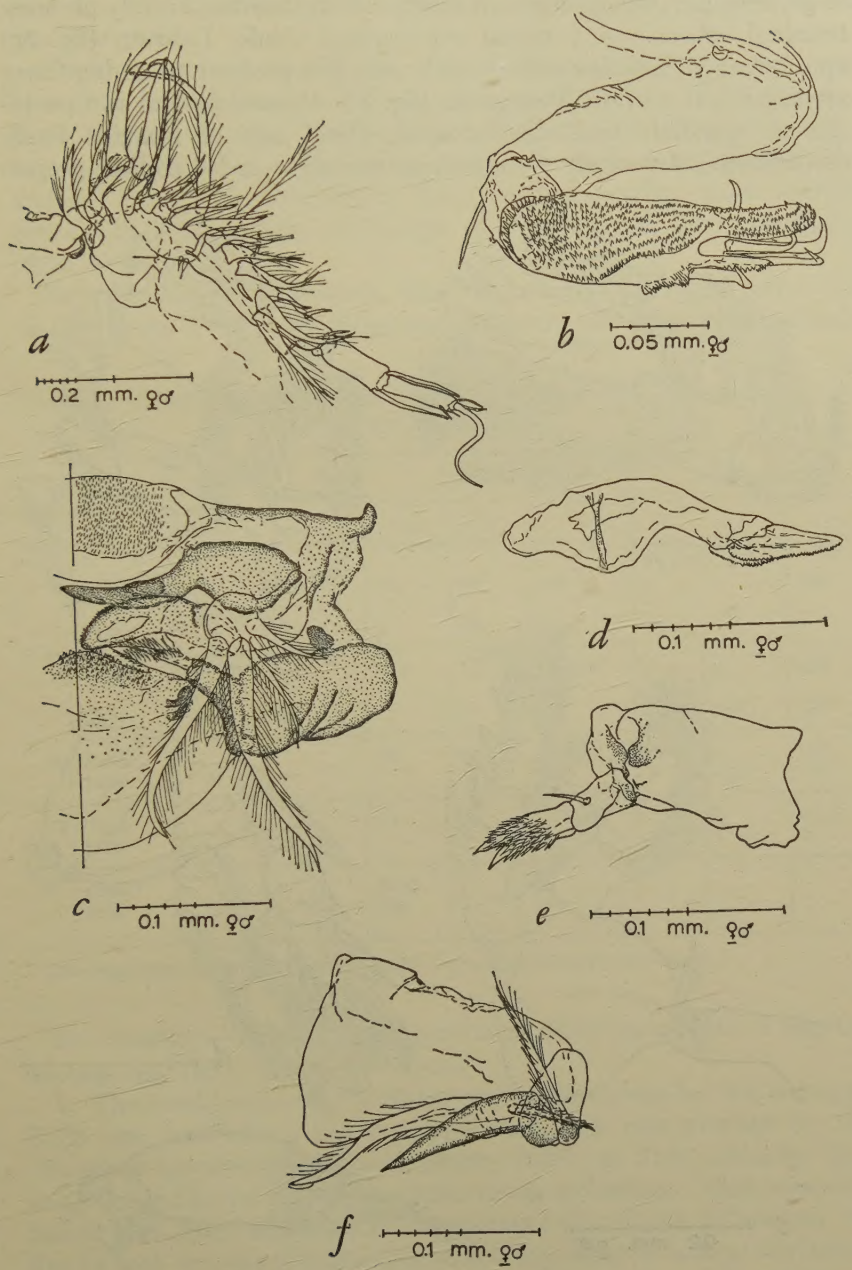


FIGURE 3.—*Nothobomolochus gibber* (Shiino, 1957), female, ventral views: *a*, left antennule; *b*, right antenna; *c*, left side of oral region, showing labrum, mandible, paragnath, maxillule and maxilla; *d*, right mandible; *e*, right maxilla; *f*, left maxilliped.

large, irregular; second segment short, rodlike, bearing 2 stiffly plumose terminal spines and 1 naked subterminal setule. Labrum (fig. 3*c*) apron-shaped, anterior surface with very fine projections giving fuzzy appearance to surface. Paragnath (fig. 3*c*) situated medial and posterior to maxillule base, bladeshaped, distal half of margins finely denticulated. Anteriorly V-shaped, posteriorly rounded padlike projec-

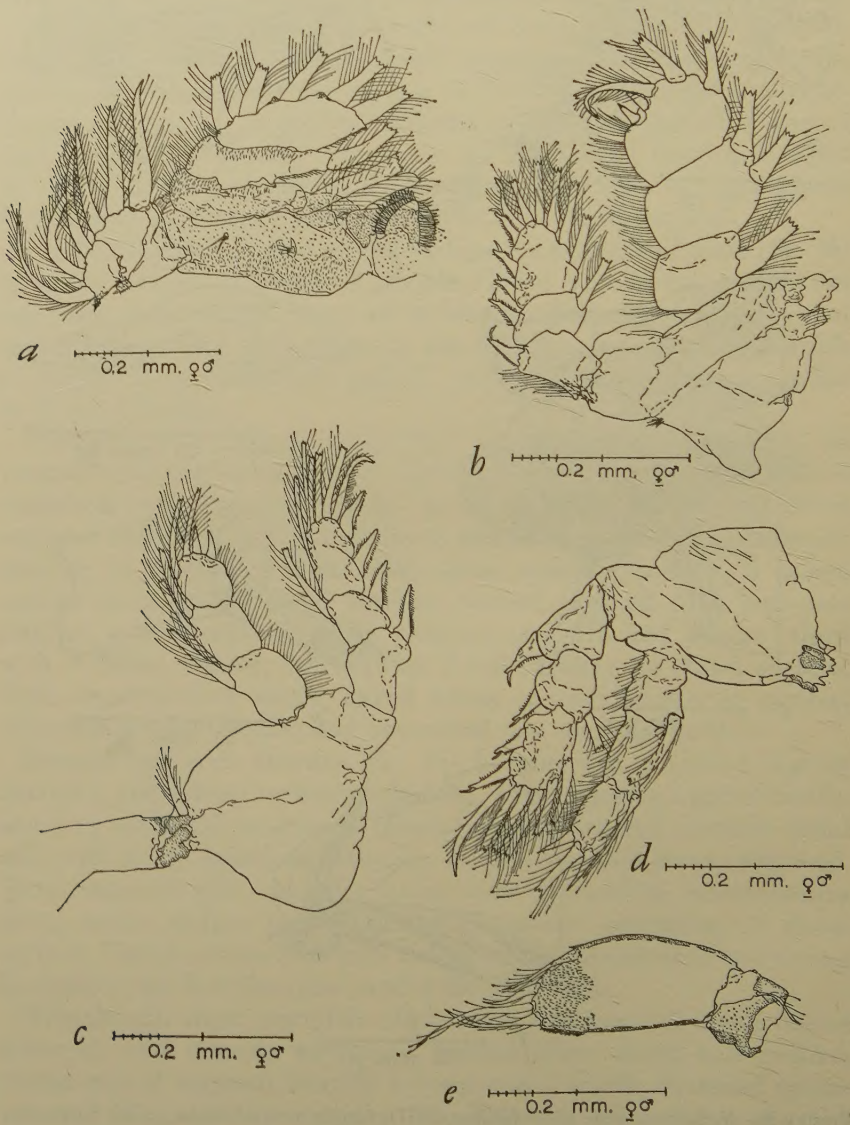


FIGURE 4.—*Nothobomolochus gibber* (Shiino, 1957), thoracic legs: *a*, left first, ventral view; *b*, left second, anterior view; *c*, right third, anterior view; *d*, right fourth, anterior view; *e*, right fifth, ventral view.

tion present immediately posterior to maxilla, extending between maxillae bases.

Female and male maxilliped (fig. 3*f*) 2-segmented, base situated lateral to maxilla base, body extending anteriorly to antenna base. First segment strongly developed, broad proximally, tapered distally, bearing single, long, finely plumose seta from knob on distal inner surface. Second segment short, inner surface cuplike, outer surface rounded; distal surface with large, sharply curved claw and finely plumose seta.

Thoracic legs 1–4 biramous, fifth leg uniramous. Ramal count 3–3 on first 4 legs. For nature of legs and armature, see figure 4 and table 2.

TABLE 2.—*Armature of thoracic legs I–V of the female and male of* Nothobomolochus gibber (*Shiino, 1957*)

Leg	Surface	Interpodal Plate	Protopodite	Exopodite			Endopodite		
				1	2	3	1	2	3
I	Outer	C	ss	dh	dh	dh	c	c	c,5P
	Inner		P,sss	c	3P	3P	P	c,P	c
II	Outer	c	c,p	c,fH	fH	3fH,2P	c	c	c,2h
	Inner		ss		P	4P	P	c,2P	c,3P
III	Outer			fH	fH	2fH,2P	c	c	c,2h
	Inner		P		P	4P	P	c,2P	c,2P
IV	Outer			fH	fH	2fH,2P	c	c	c,h,P
	Inner				P	4P	P	P	h
V	Outer*		p	p,r,p					
	Inner			r,2p					

*The designations "protopodite" and "exopodite" are used with some reservation.

DISCUSSION.—The Eniwetok specimens differ from Shiino's original description (1957) in several respects:

1. The total length is only 80 percent of that given for the holotype (2.28 mm for Shiino's holotype specimen, 1.82 mm average for the Eniwetok specimens) although Shiino (1957, p. 416) indicates that the holotype is the largest specimen in his collection. Other measurements also differ although it is suggested that these differences are due to both the size of the holotype and the effect of natural variation.

2. The caudal rami of the Eniwetok specimens have 3 setules on the outer surface while Shiino indicates only 2. The third setule, however, may have been overlooked as all 3 are small and almost transparent.

3. Part of the surface of the labrum has a "fuzzy" appearance due to numerous, minute projections. Shiino figures the labrum without the projections.

4. Shiino states (p. 415) that, in the first thoracic leg, "both the rami (are) fringed by stout long spines with multiserial barbs; . . ." This condition was not evident in the Eniwetok material.

5. The antennae of the Eniwetok specimens possess 2 denticulated subterminal setae on the third segment while Shiino indicates that there is only 1.

In spite of these differences, the Eniwetok specimens agree closely with Shiino's original description and, based on this similarity, are believed to be conspecific with *N. gibber*.

Pseudotaeniacanthus species

FIGURES 5, 6

MATERIAL.—1 adult male (USNM 120740) from the external surface of *Acanthurus gahhm* (Forskål).

MEASUREMENTS (in mm).—1 male:

Greatest length, excluding caudal setae	1. 73
Length of prosome	0. 81
Width of prosome	0. 63
Length of cephalothorax	0. 49
Length of genital segment	0. 18
Width of genital segment	0. 27

DESCRIPTION.—Body (fig. 5*a*) of general cyclopoid shape: cephalothorax of general bell shape, consisting of cephalon, maxilliped-bearing and first pedigerous segments. Anterior end of cephalothorax rounded although slightly concave medially, set off from rest of cephalothorax by lateral indentation and line of heavy sclerotization extending medially and curving posteriorly from lateral indentation. Lateral margins flatly convex, posterior margin irregularly concave. Second pedigerous segment distinct from cephalothorax, width approximately nine-tenths that of cephalothorax; lateral surfaces winglike, lateral margins flatly convex. Third pedigerous segment distinct from second, appearing slightly narrower than second although of similar shape. Fourth pedigerous segment distinct from third, approximately three-fourths its length, lateral surfaces winglike, as in preceding free pedigerous segments, although lateral margins more rounded.

Fifth pedigerous segment without winglike lateral projections, forming first segment of urosome; slightly narrower anteriorly than posteriorly. Genital segment (fig. 5*b*) barrel-shaped, slightly more than one and one-half times the length of fifth pedigerous segment;

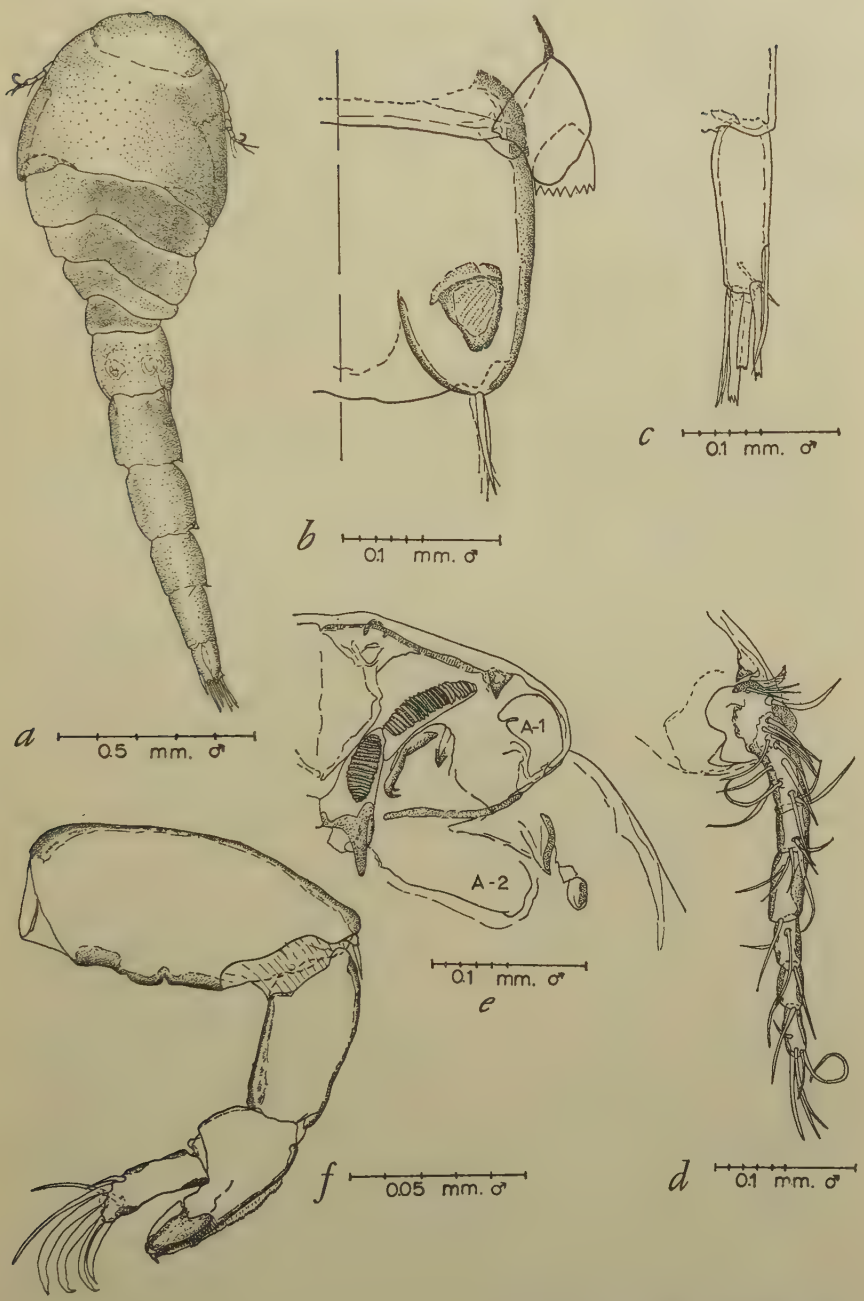


FIGURE 5.—*Pseudotaeniacanthus* species, male: *a*, dorsal view; *b*, left side of genital segment ventral view; *c*, left caudal ramus, ventral view; *d*, left antennule, ventral view; *e*, antenna, region showing antennule base (A–1), antennal base (A–2), and adjacent processes; *f*, right antenna, posterior view.

lateral posterior region lobate, lobes bearing genital openings and sixth legs. Sixth leg consisting of single finely plumose setule. Four segments present posterior to genital segment, first approximately equal to length of genital segment, second approximately nine-tenths its length, third and fourth approximately three-fourths its length. Posterior segments narrower than anterior, lateral margins of first 3 almost parallel, fourth tapered posteriorly, posterior margin with small anal indentation and distinct lateral concavities, at place of attachment and articulation of caudal rami. Caudal rami (fig. 5*c*) elongate, subrectangular, with setule-bearing indentation in distal half of outer surface; distal surface with 3 naked setae and 1 naked setule, additional naked setule present on dorsal surface just proximal to distal end.

Antennule (fig. 5*d*) 6-segmented, attached to anterior-lateral ventral surface of cephalothorax, adjacent to small, spikeshaped projection from lateral anterior surface of cephalothorax. First segment (may represent 2 fused segments) strongly flattened proximally, rodlike distally; bearing 19 naked or very lightly plumose setules. Second segment approximately one-third the length of first, with 4 naked or lightly plumose setules. Third segment approximately half the length of first, with 3 naked setules. Fourth segment slightly more than one-third the length of first, bearing 3 naked setules. Fifth segment slightly less than one-third the length of first, with 2 naked setules. Sixth segment slightly more than one-third the length of first, rounded distally, bearing single naked setule from medial posterior surface, 5 naked setules from distal surface. Antenna (fig. 5*f*) 4-segmented, situated posterior and medial to antennule base. First segment strongly developed, distal surface with naked setule. Second segment approximately half the length of first, subrectangular. Third segment, excluding terminal processes, slightly shorter than second with deep indentation in medial outer surface; distal surface with 2 spatulate and one clawlike projection, inner lateral surface of segment and spatulate process with denticulated membrane or individual denticulations. Fourth segment arising from indentation in third, rodlike, bearing 7 naked setae and setules distally.

Mandible (fig. 6*a*) 1-segmented, broad proximally, irregularly tapered distally, with spineshaped projection distally; second spineshaped projection arising from distal half of posterior surface; both projections with denticulations, distalmost with single longitudinal row on posterior surface, proximal projection with 2 rows. Maxillule (fig. 6*a*) nodular, situated immediately posterior to mandible base, bearing 4 naked setae. Maxilla (fig. 6*a*) appearing 2-segmented, first segment swollen, nodular, second segment arising from inner lateral surface of first, rodlike, bearing 2 naked setules and single spatulate

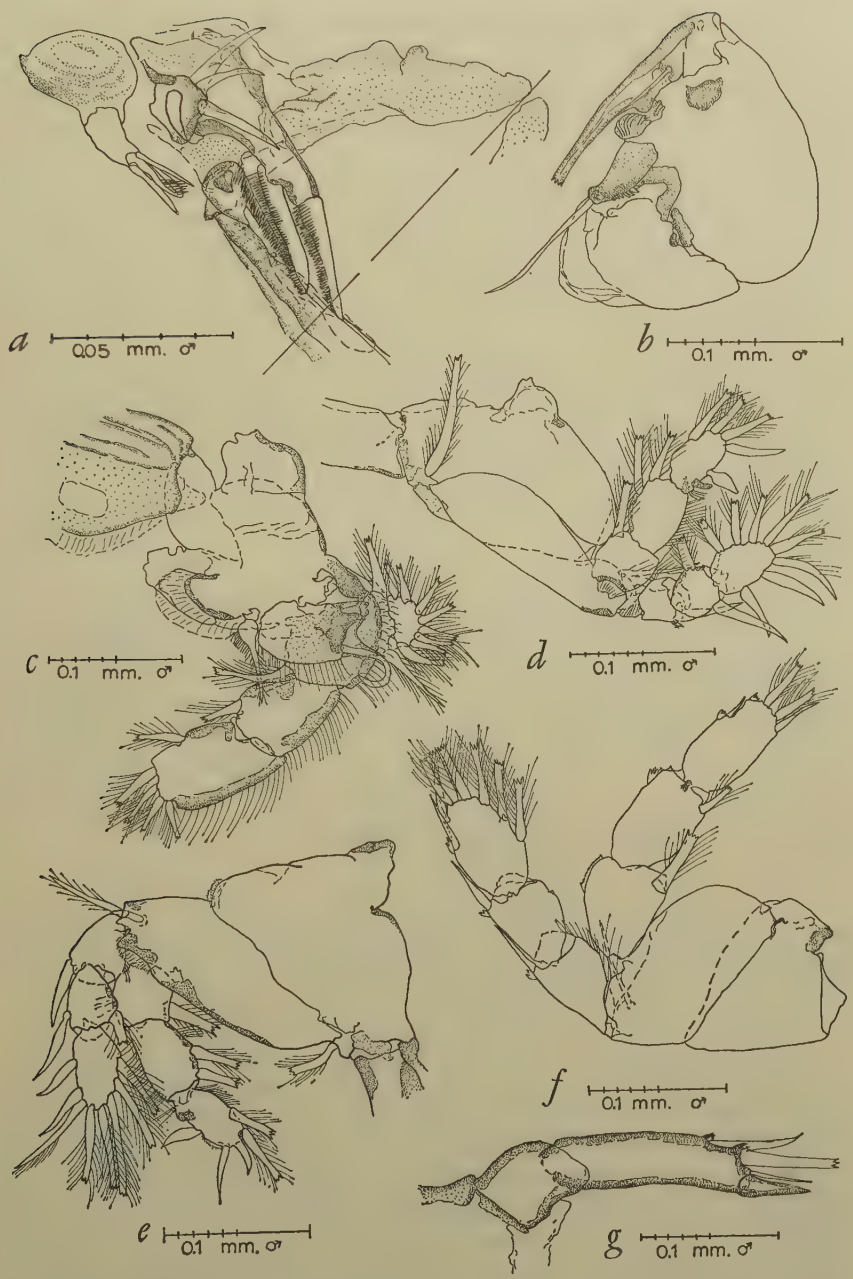


FIGURE 6.—*Pseudotaeniacanthus* species, male, ventral views: *a*, right side of oral region, showing mandible, paragnath, maxillule, and maxilla; *b*, left maxilliped. Thoracic legs: *c*, right first, posterior view (see table 3 for discussion of position of rami); *d*, right second, anterior view; *e*, right third, anterior view; *f*, left fourth, anterior view; *g*, left fifth, anterior view.

process distally, spatulate process denticulated distally. Paragnath (fig. 6*a*) small, nodular, without distinctive armature.

Ventral surface of cephalothorax with numerous heavily sclerotized knobs, adhesion processes and spikes. Postantennal process (fig. 5*e*) most prominent, extending as ridge from lateral anterior surface posteriorly to oral region, terminating as spinelike projection; ridge bearing 2 adhesion pads. Postantennal processes contiguous at base but not fused. Prominent pair of spinelike projections situated immediately lateral to antenna base, in position of postantennal process of many caligoids.

TABLE 3.—*Armature of thoracic legs I–V of the male of* Pseudotaeniacanthus *species*

Leg	Surface	Interpodal Plate	Protopodite		Exopodite			Endopodite		
			1	2	1	2	3	1	2	3
I	Outer*	m				P	3P	c	c	c,2P
	Inner		m,p		c,P	P	4P	P	c,P	c,3P
II	Outer			p	dm,H	H	2H,Q′#,P	c	c	c,h,2p′
	Inner		P	fm	c	P	4P	P	2P	3P
III	Outer			p	H	H	2H,Q′#,P	c	c	c,h,p′,fm, p′,h
	Inner		P	fm	c	P	4P	P	c,2P	c,2P
IV	Outer			p	dm,H	dm,H	dm,H,H,2P	fm	fm	fm,h,fm,P
	Inner				c	?	4P	P	P	p′,P
V	Outer				dm,p′,dm, P′,p′,dm, H					

*Position of rami in figure 6*c* reversed due to flattening and consequent movement during mounting; endopodite situated almost behind (posterior) exopodite in appendage in situ.

#Seta-like process with plumosities on one side, naked on other.

?Armature element may have been lost in handling.

Maxilliped (fig. 6*b*) 3-segmented, situated posterior and slightly medial to maxilla base. First segment irregular, base partially formed by heavily sclerotized ring; single naked seta present, on anterior inner surface. Second segment strongly developed, inner surface with large, heavily sclerotized, knob-tipped projection, projection with single row of denticles; inner distal surface with 2 contiguous oval adhesion pads. Third segment small, distinct from long, spinelike terminal process, bearing single, setalike accessory process.

Thoracic legs I–IV biramous, rami 3-segmented; fifth leg uniramous, 2-segmented. For nature of legs and armature see figures 6*c-g* and table 3.

DISCUSSION.—The single male specimen from Eniwetok differs from the diagnosis of the genus given in Yamaguti (1963) in the following characteristics:

1. The lateral extensions of the second to fifth pedigerous segments are not as large.

2. The antenna is 4-segmented, not 3-segmented. The condition exhibited in the third and fourth segments of the antenna of the Eniwetok specimen suggests that the terminal segment of the antenna of previously described species may be composed of 2 fused, or partially fused segments.

3. The postantennal processes are contiguous at their base but are not fused and do not form the characteristic Y-shaped structure present on other members of the genus. Additionally, although there are 2 adhesion pads on each postantennal process, the projections on these pads do not have the characteristic brushlike appearance of those on other members of the genus. These two differences, however, suggest that the structure, in the group to which the Eniwetok specimen belongs, is of a primitive nature.

In spite of these differences, the specimen is placed in the genus *Pseudotaeniacanthus* not only because the characteristics, other than the above, coincide most closely with those previously described for other members of the genus but also because there is an overall similarity of the postantennal process of the Eniwetok specimen with that of the other members.

Family PANDARIDAE

Pandarus cranchii Leach

Pandarus cranchii Leach, 1819, p. 535.—Lewis, 1966, p. 81, figs. 10–13.—Cressey, 1967, p. 9, figs. 27–33.

For remaining synonymy, see Lewis (1966) and Cressey (1967).

HOSTS AND DISTRIBUTION.—See Lewis (1966).

MATERIAL.—4 females (USNM 120746) from the external surface of *Galeocerdo cuvieri* (Lesueur).

MEASUREMENTS (in mm).—4 females:

	mean	*range*
Length of body, excluding caudal setae	6.87	6.51–7.14
Length of cephalothorax, including frontal region	4.06	3.85–4.33
Width of cephalothorax	4.26	3.96–4.48
Length of genital segment	2.61	2.37–2.74
Width of genital segment	2.94	2.74–3.03
Length of caudal rami	1.57	1.30–1.70
Length of anal lamina	1.63	1.52–1.74
Length of egg strings (6 strings)	4.07	3.55–5.00

DESCRIPTION.—See Lewis (1966).

Family Dissonidae

Dissonus heronensis Kabata

Figures 7–9

Dissonus heronensis Kabata, 1966a, p. 221, fig. 5.

Host and distribution.—"Unspecified fish of the family Balistidae" (Kabata, 1966a, p. 221), Heron Island, Queensland, Australia.

Material.—7 females and 1 male (USNM 120741) from the gill cavity of *Balistoides viridescens* (Bloch and Schneider).

Measurements (in mm).—5 females and 1 male:

	female		male
	mean	*range*	*male*
Total length, excluding caudal setae	1.96	1.82–2.03	1.51
Length of prosome	1.15	1.12–1.19	0.88
Width of prosome	0.85	0.79–0.88	0.67
Length of cephalothorax	0.87	0.83–0.94	0.61
Length of genital segment	0.56	0.49–0.63	0.52
Width of genital segment	0.47	0.43–0.50	0.31
Length of abdomen	0.20	0.11–0.25	0.11
Length of egg strings (8 strings)	1.43	1.37–1.48	

Description.—Female cephalothorax (fig. 7*b*) consisting of cephalon and first 2 thoracic segments, strongly arched in transverse section. Frontal region (fig. 7*g*) membranous, narrow, forming slightly less than 10 percent of length of cephalothorax; with small, median notch in anterior margin. Lateral margin irregularly convex, with fine membrane posteriorly. Posterior lateral cephalothoracic region lobate, projecting to posterior half of free second pedigerous segment. Major dorsal cephalothoracic grooves consisting of pair of convex grooves extending anteriorly from junction of inner margin of posterior lateral cephalothoracic region and outer margin of free second pedigerous segment, terminating lateral and slightly posterior to pair of small, slightly projecting heavily sclerotized ridges. Ocular region indistinct, situated on median longitudinal axis of body, anterior to ridges.

Female free second pedigerous segment slightly less than twice as wide as long, division between segment and cephalothorax distinct; lateral regions lobate, extending posteriorly to posterior region of third pedigerous segment; lobes with membrane along outer margin. Third pedigerous segment distinct from second, width slightly more than twice the length, segment without posterior extensions of lateral regions. Fourth pedigerous segment distinct from third, width slightly more than one and one-half times the length; broadest medially, tapered to anterior and posterior ends.

Female genital segment (fig. 7*d*) generally ovoid although shape variable; indistinctly separable from fourth pedigerous segment.

Platelike formation of cuticle covering most of dorsal surface, ventral surface with 2 series of nodules, each nodule bearing bifid hairlike projections, anterior series consisting of transverse row of 4 nodules, second series usually forming longitudinal row of 3 nodules on each

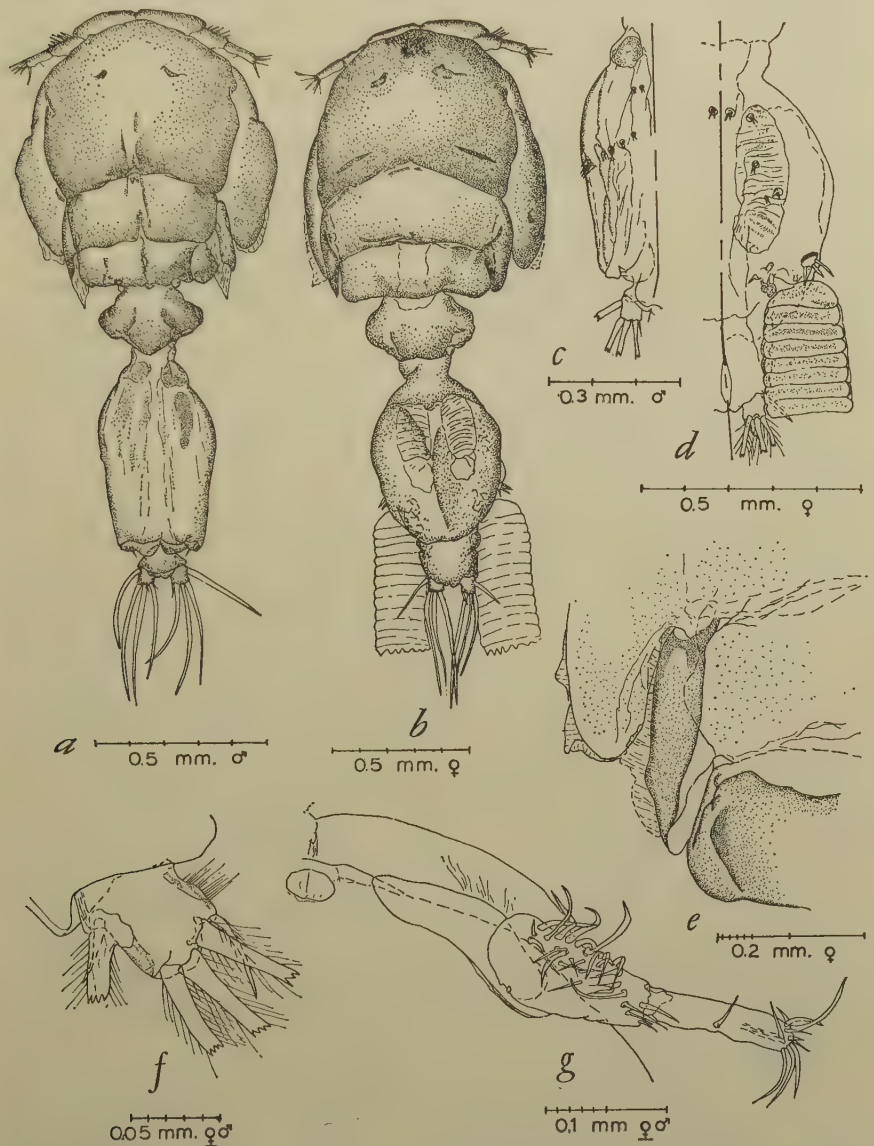


FIGURE 7.—*Dissonus heronensis* Kabata, 1966, dorsal views: *a*, male; *b*, female. Ventral views: *c*, male genital segment; *d*, female genital segment; *e*, female first, second, and third pedigerous segments (P–I, II, III); *f*, right caudal ramus; *g*, right antennule and adjacent frontal region.

side although nodules not always in row. Fifth leg (fig. 9*e*) situated on lateral ventral surface in posterior half of segment, consisting of palp bearing 4 plumose setules, Abdomen 1-segmented, distinctly separable from genital segment. Lateral margins, in adult, irregular, anterior surface broader than posterior. Posterior surface flat laterally, broadly bilobed medially, junction of lobes forming anal indentation. Caudal rami (fig. 7*f*) small, subrectangular, with 3 plumose terminal setae, 1 plumose setule on inner distal surface, and plumose seta and setule on proximal lateral surface.

Male cephalothorax and free pedigerous segments similar to those of female (fig. 7*a*). Genital segment (fig. 7*c*) elongate, rounded an-

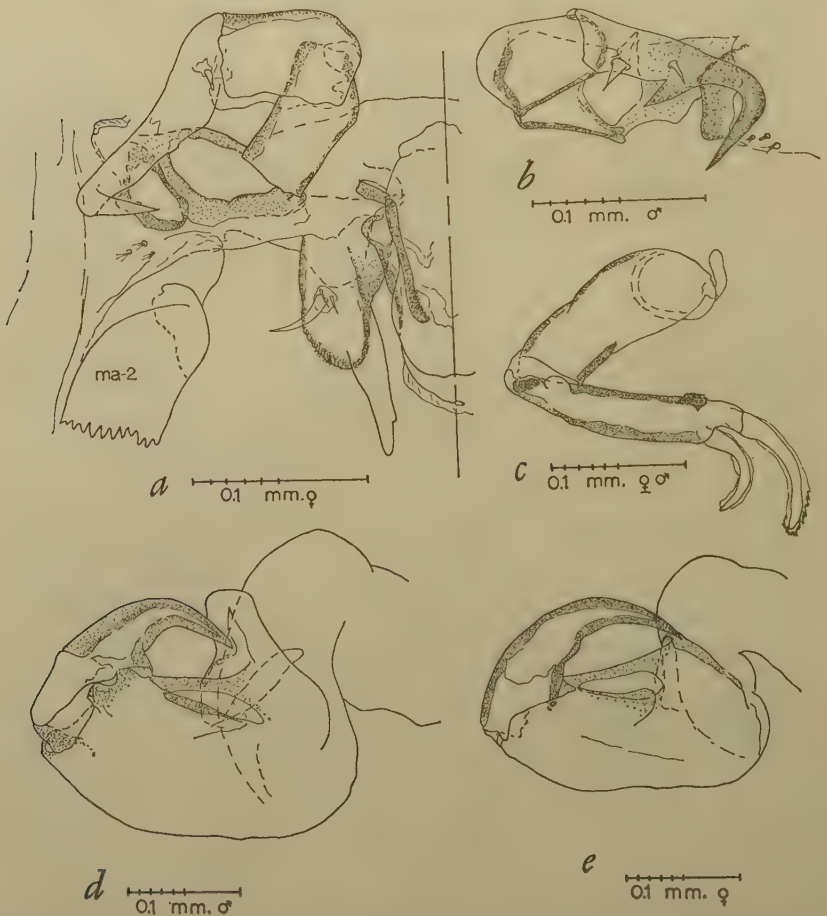


FIGURE 8.—*Dissonus heronensis* Kabata, 1966, ventral views: *a*, female oral region, showing antenna, mouth cone, mandible, maxillule, maxilla base (ma–2), postantennal process and postoral process; *b*, male left antenna and postantennal process; *c*, right maxilla; *d*, male left maxilliped; *e*, female left maxilliped.

teriorly, tapered slightly posteriorly; process-bearing nodules present although longitudinal row extending posterolaterally, consisting of 4 nodules, not 3 as in female. Fifth leg (fig. 9*f*) situated on lateral ventral surface, consisting of 5 lightly plumose setules originating from slight swelling. Sixth leg (fig. 9*g*) lappet-shaped, situated on lateral posterior surface of segment, bearing 2 lightly plumose setules. Abdomen 1-segmented, short; narrow anteriorly, flared sharply posteriorly, posterior surface as in female. Caudal rami as in female.

Female and male antennule (fig. 7*g*) 2-segmented, situated on lateral anterior ventral surface of cephalothorax and adjacent frontal region. Second segment approximately nine-tenths the length of first; first broader proximally than distally, lateral margins irregular; anterior ventral surface of first segment bearing approximately 28 lightly plumose setae and setules. Second segment rodlike, medial posterior surface with one naked setule, distal surface with 12 naked setules. Female antenna (fig. 8*a*) 3-segmented, situated posterior and medial to antennule base. First segment subrectangular, attached to heavily sclerotized padlike projection of cephalothorax. Second segment subrectangular, slightly longer than first segment. Third segment incompletely fused to clawlike terminal process, with setule-like accessory process proximally. Segments of male antenna (fig. 8*b*) similar to those of female although second with slight indication of adhesion surfaces (not shown in figure), terminal process of third segment with accessory claw proximally, segment with second accessory process at indistinct junction with terminal process.

Female and male mandible (fig. 8*a*) 4-parted, distalmost part flattened, inner margin with 10–12 denticulations. Female and male postantennal process (figs. 8*a*, *b*) situated posterior and slightly lateral to antenna base, consisting of 3 minute nodules, each with one or more hairlike processes. Female and male postoral process consisting of long, spatulate spine, male spine with light, spinelike accessory process distally. Female and male maxillule (fig. 8*a*) situated immediately lateral to mouth cone base, consisting of lobate projection, forming base of postoral process, bearing nodule, with seta and 2 setules, on proximal outer surface. Projection with slight adhesion surface on distal half of outer surface. Female and male maxilla (fig. 8*c*) 2-segmented, situated lateral and slightly posterior to maxillule. Segment lengths about equal, first more strongly developed, second rodlike, with small membrane on distal inner surface and 2 saber-shaped terminal processes. Innermost terminal process approximately one and one-half times the length of outermost, both with fine membranes, distal portion of membranes forming denticulations on innermost terminal process.

Female maxilliped (fig. 8*e*) 2-segmented, situated immediately posterior and medial to maxilla base. First segment irregular, strongly developed, proximal end fused with cephalothorax; large, shelflike projection present on proximal inner surface, receiving distal end of second segment terminal process when segment flexed. Second segment indistinctly separable from clawlike terminal process, with accessory

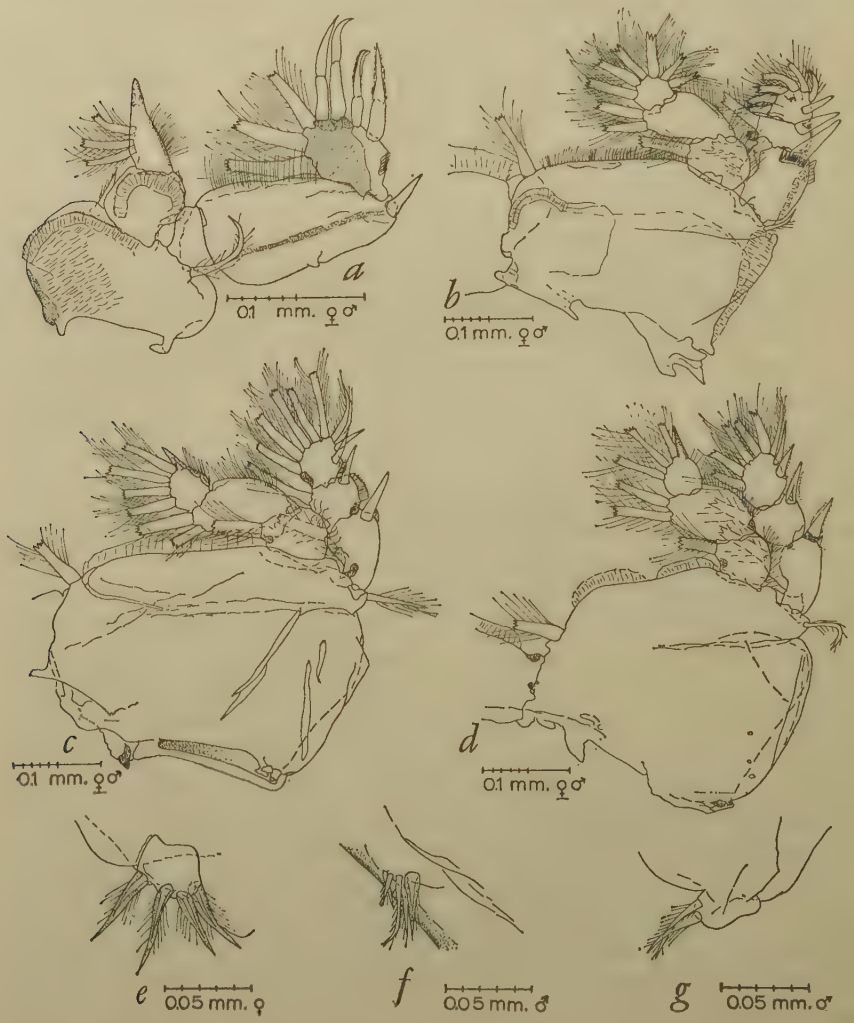


FIGURE 9.—*Dissonus heronensis* Kabata, 1966, right thoracic legs, anterior views: *a*, first; *b*, second; *c*, third, *d*, fourth. Legs, ventral views: *e*, female right fifth; *f*, male right fifth; *g*, male left sixth.

processes. Male maxilliped (fig. 8*d*) similar to that of female except shelflike projection of first segment much smaller.

For nature of thoracic legs and armature, see figures 9*a–d* and table 4.

DISCUSSION.—The male specimen from Eniwetok differs slightly from the description given by Kabata (1966a) for the male specimen from Heron Island. The differences are in some of the armature elements on the thoracic legs and include the absence, on the Eniwetok specimen, of a small denticulation on the second segment of the endopodite of the first leg and the presence of a coarsely frilled membrane instead of 3 spinules on the second segment of the exopodite of the first thoracic leg.

TABLE 4.—*Armature of thoracic legs I–IV of the female and male of* Dissonus heronensis *Kabata, 1966*

Leg	Surface	Interpodal Plate	Protopodite	Exopodite			Endopodite		
				1	2	3	1	2	3
I	Outer		p	h	2fH,2H		fm*	c,Cl	
	Inner		fm*,a,p	c	3P			3p	
II	Outer	m	m,p	m,dm,H	fm,H	fm,H,p	c	c	c,3P
	Inner		P,c	c,P	c,P	5P	P	c,2P	3P
III	Outer	m	p	fm,H	fm,H	fm,2H,Q	c	c	c,Cl
	Inner		P,m,2s	c,P	c,P	5P	P	c,2P	4P
IV	Outer	m	s#,p	dm,fmH	fH+	fH+,p',Q	c	c	c,Cl
	Inner		P,2m	P	P	5P	P	c,2P	3P

*Frilled membrane extending across part of segment, not only on indicated surface.
#Numerous processes scattered over surfaces of segment.
+Frilled membranes very small.

Dissonus similis Kabata

FIGURES 10–12

Dissonus similis Kabata, 1966a, p. 211, figs. 1, 2.

HOST AND DISTRIBUTION.—*Spheroides hamiltoni*, Queensland, Australia.

MATERIAL.—3 females and 5 males (USNM 120742) from the gill cavity of *Arothron meleagris* (Block and Schneider); 3 females, 2 males and 2 chalimus stages (USNM 120743) from the gill cavity of *A. meleagris;* 1 female and 1 male (USNM 120744) from the gill cavity of *A. meleagris;* 2 females and 1 male (USNM 120745) from the gill cavity of *A. meleagris*.

MEASUREMENTS (in mm).—7 females and 9 males:

	females		*males*	
	mean	*range*	*mean*	*range*
Total length, excluding caudal setae	2. 18	1. 87–2. 43	1. 96	1. 73–2. 32
Length of prosome	1. 38	1. 22–1. 53	1. 24	1. 08–1. 44
Width of prosome	1. 20	1. 13–1. 26	1. 06	0. 95–1. 13
Length of cephalothorax	1. 06	0. 95–1. 13	0. 94	0. 83–1. 06
Length of genital segment	0. 56	0. 49–0. 67	0. 49	0. 45–0. 58
Width of genital segment	0. 59	0. 50–0. 61	0. 40	0. 22–0. 47
Length of abdomen	0. 21	0. 11–0. 32	0. 15	0. 13–0. 18
Length of egg strings (5 strings)	1. 63	1. 44–1. 80		

DESCRIPTION.—Female cephalothorax (fig. 10*a*) consisting of cephalon and first 2 thoracic segments, strongly arched in transverse section. Frontal region narrow, projecting slightly past anterior end of cephalothorax, with wide membrane along anterior surface, membrane with median notch. Lateral margins convex, bearing fine membrane posteriorly; posterior lateral region lobate, extending posteriorly to posterior half of second pedigerous segment, with small cup-shaped indentation laterally, indentation associated with single hairlike process (not shown on figure). Single pair of major dorsal cephalothoracic grooves present, extending anteriorly from junction of posterior lateral and posterior median cephalothoracic regions, terminating in anterior half of cephalothorax. Ocular region (fig. 10*f*) distinct, situated at anterior end of cephalothorax, overlaid by small, anteriorly lobed plate. Pair of heavily sclerotized, knoblike projections present just anterior to plate, similar in shape, and position to conspicilla of *Nesippus*.

Female free second pedigerous segment approximately two and one-half times as wide as long, division between cephalothorax and third pedigerous segment distinct. Lateral regions lobate, extending posteriorly to posterior region of third pedigerous segment, without membrane along outer margin. Third pedigerous segment approximately three times as wide as long, with slight posterior extensions of lateral regions. Fourth pedigerous segment distinct from third, approximately three-fourths its width, length approximately one-half the width.

Female genital segment (fig. 10*d*) varying in shape from ovoid to circular, separated from fourth pedigerous segment by short, necklike formation with pair of small, saddle-shaped areas of heavy sclerotization laterally. Dorsal surface of genital segment platelike, anterior two-thirds of ventral surface bearing numerous (up to 60) bifid spines (fig. 10*e*). Fifth leg (fig. 12*f*) situated on ventral posterior lateral surface, consisting of palp bearing 3 plumose setules and 1 lightly

plumose, spinelike process. Abdomen 1-segmented, distinct from genital segment, lateral margins flatly convex, posterior surface biconcave. Caudal rami (fig. 10*h*) subrectangular, bearing 3 plumose setae and 1 plumose setule distally as well as plumose seta and setule from proximal half of outer surface; inner surface of rami ovoid.

Male cephalothorax and free pedigerous segments (fig. 10*b*) similar to those of female. Genital segment (fig. 10*c*) barrel-shaped, with

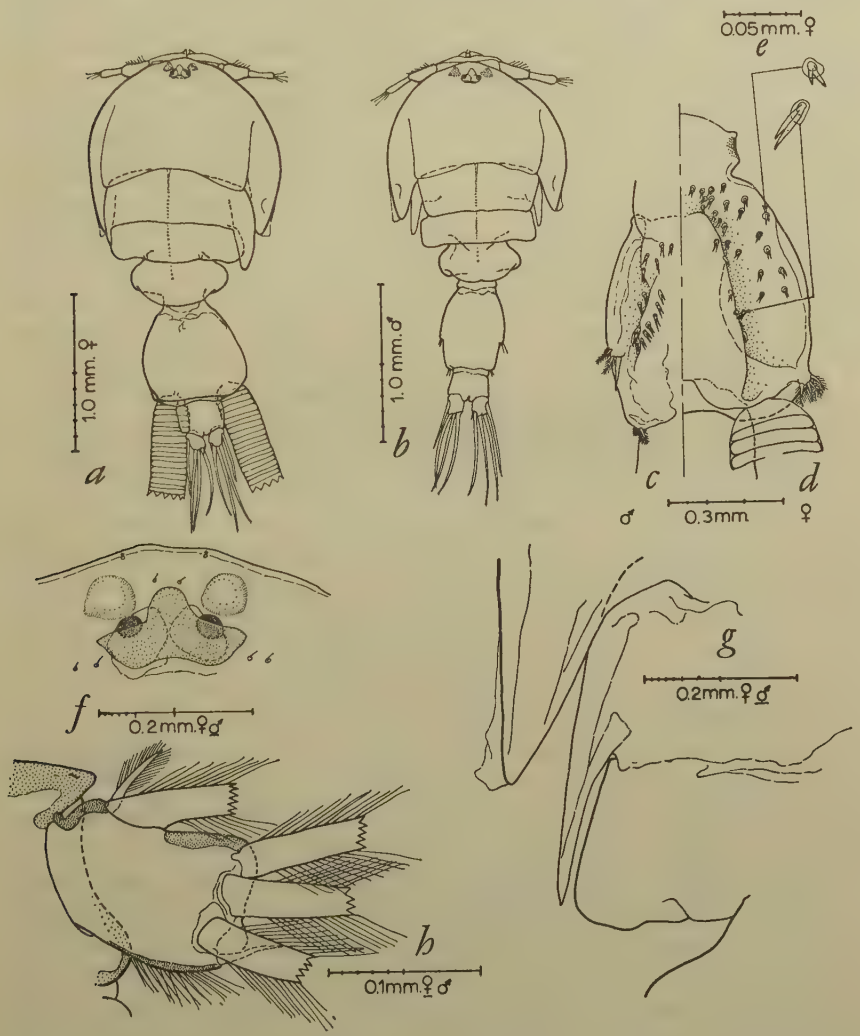


FIGURE 10.—*Dissonus similis* Kabata, 1966, dorsal views: *a*, female; *b*, male. Ventral views: *c*, male genital segment; *d*, female genital segment; *e*, processes on female genital segment; *f*, ocular region (dorsal view); *g*, first, second, and third pedigerous segments; *h*, caudal ramus.

approximately 30 bifid spines on ventral surface. Fifth leg (fig. 12*g*) situated on posterior medial lateral surface, consisting of slight indentation bearing 3 plumose setules and single naked, spinelike projection. Sixth leg (fig. 12*h*) situated on small projection of ventral lateral posterior surface, consisting of 3 plumose setules. Abdomen short, 1-segmented, slightly wider posteriorly than anteriorly. Caudal rami as in female.

Female and male antennule (fig. 11*a*) 2-segmented, situated on lateral anterior ventral surface of cephalothorax and adjacent portion of frontal region. Second segment approximately three-fourths the length of first, first clubshaped, bearing approximately 26 lightly plumose setules (plumosites not shown in figure) on anterior and anterior ventral surface. Second segment rodlike, with 1 naked setule on medial posterior surface and 12 on distal surface. Female antenna (fig. 11*b*) 3-segmented, situated posterior and slightly medial to antennule base. First segment dactyliform, attached to padlike projection of cephalothorax. Second segment subrectangular, approximately the same length as first segment. Third segment incompletely fused to clawlike terminal process, bearing single, setule-like accessory process. First and second segments of male antenna (fig. 11*c*) similar to those of female except second with small, earshaped area of heavy sclerotization on distal posterior surface. Third segment fused to clawlike terminal process, accessory processes consisting of spinelike secondary claw and 2 naked, setule-like structures.

Female and male mandible (fig. 11*b*) 4-parted, distalmost part flattened, inner margin with 12 denticulations. Female postantennal process (fig. 11*b*) situated posterior and slightly lateral to antenna base, consisting of 3 minute nodules, each appearing to have several hairlike processes. Male postantennal process (fig. 11*c*) consisting of 2 nodules (posteriormost of female not visible on male), each with several hairlike processes. Female and male maxillule (fig. 11*b*) situated immediately lateral to mouth cone base, consisting of 3 naked setules appearing to arise directly from lobate projection fitting over knoblike extension of cuticle. Lobate projection bearing elongate, slightly curved spine forming postoral process, spine with minute nodule on distal inner surface. Lobate projection and spine without distinct indication of adhesion surface on either male or female. Female and male maxilla (fig. 11*d*) 2-segmented, situated lateral and slightly posterior to maxillule. Second segment slightly less than three-fourths the length of first (including articulation and muscle attachment surface at proximal end of first). First segment subrectangular, more strongly developed than second, second rodlike, with pair of denticulated membranes in distal half and pair of saber-shaped terminal processes. Innermost terminal process approximately

twice the length of outermost, both with fine membranes, membranes extending to tip of innermost terminal process, forming complex series of denticulation (fig. 11*e*).

Female and male maxilliped (fig. 11*f*) 2-segmented, situated immediately posterior and medial to maxilla base. First segment strongly developed, with long, recurved articulation and muscle attachment surface embedded in cephalothorax; inner surface with large, shelflike projection, projection (fig. 11*g*) bearing 2-parted nodule, distal part spherical, with approximately 3 ridges forming roughened surface. Second segment distinct from clawlike terminal process, bearing single, minute, setule-like accessory process; terminal process with fine, longitudinal ridges distally.

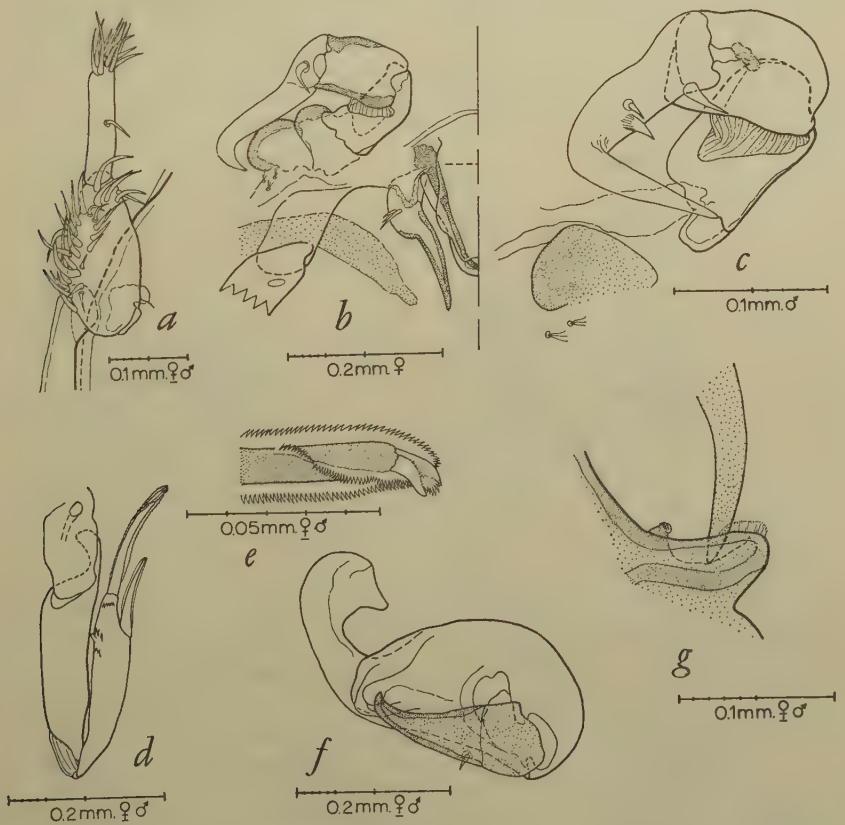


FIGURE 11.—*Dissonus similis* Kabata, 1966, ventral views: *a*, left antennule; *b*, female oral region showing antenna, postantennal process, mouth cone, mandible, maxillule, postoral process, and maxilla base; *c*, male right antenna and postantennal process; *d*, right maxilla; *e*, distal region of innermost terminal process of maxilla; *f*, left maxilliped; *g*, shelflike indentation on first segment of maxilliped.

For nature of thoracic legs and armature see figures 12*a–e* and table 5. Variation present in armature of second segment of endopodite of first thoracic leg; basic armature shown in table 5, consisting of 3 setae on inner surface, 1 terminal spinelike projection and 6 more or less lobulate projections of outer surface in addition to plumosities on outer surface. Variation exhibited in number of lobulate projections and expressed in decrease from basic number.

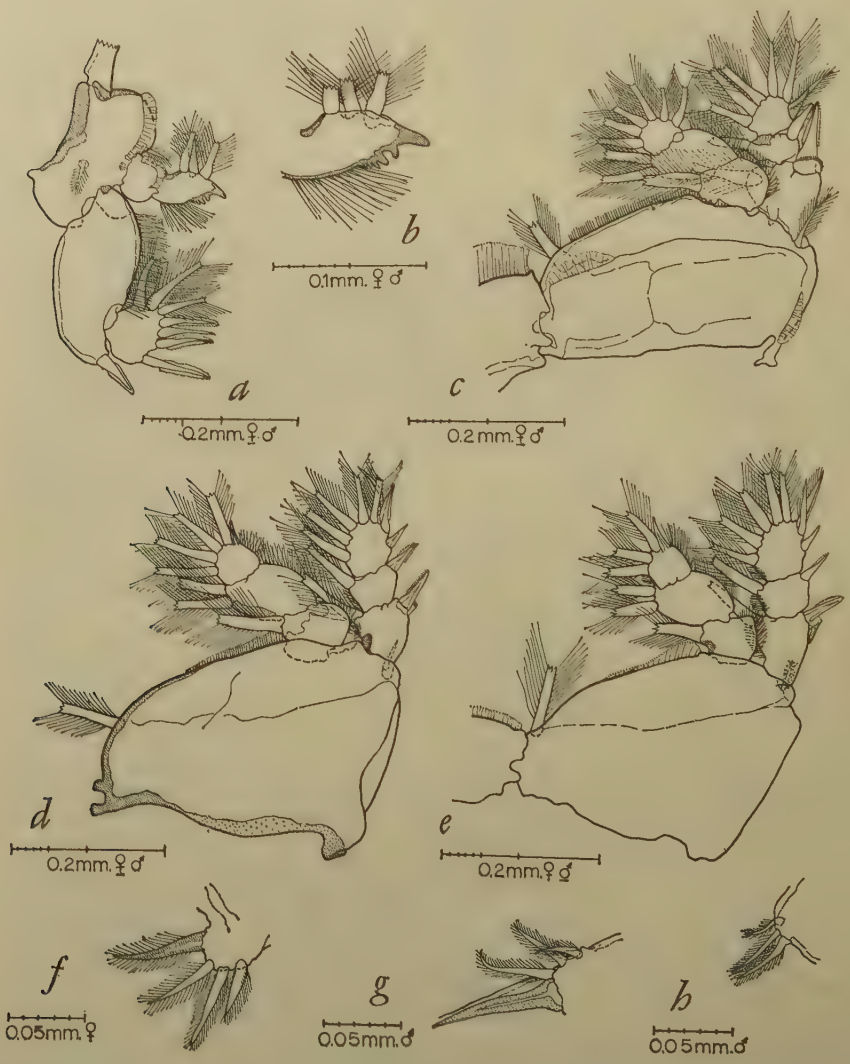


FIGURE 12.—*Dissonus similis* Kabata, 1966, right thoracic legs, anterior views: *a*, first; *b*, second segment of endopodite of first; *c*, second; *d*, third; *e*, fourth. Legs, ventral views: *f*, female left fifth; *g*, male right fifth; *h*, male right sixth.

Discussion.—The female Eniwetok specimens differ from Kabata's original description (1966a, female only) in several respects:

1. The length is less than that given for *D. similis* by Kabata (average of 2.18 mm for the Eniwetok specimens, 2.84 mm for Kabata's two specimens).

2. The pad associated with the maxillule is indicated by Kabata (p. 213) to have numerous delicate ridges. These were not clearly seen on the Eniwetok material although they may be visible with phase contrast.

3. The minute process figured on the distal end of the spine associated with the above-mentioned pad is not visible in the Eniwetok material.

Table 5.—*Armature of thoracic legs I–IV of the female and male of* Dissonus similis *Kabata, 1966*

Leg	Surface	Interpodal Plate	Protopodite	Exopodite			Endopodite		
				1	2	3	1	2	3
I	Outer		p	fH	2fH, 2H			c, 6cl, Cl	
	Inner		m, p	c	3P		m	3P	
II	Outer	m	m, p	fm, fH	fH	H, mp'*, 2P	c	c	3P
	Inner		m, P, C	c, P	P	3P	P	c, 2P	3P
III	Outer	m	p	fm, fH	fH	H, 2mp#, P	c	c	c, Cl
	Inner		P, m	c, P	c, P	4P	P	c, 2P	c, 4P
IV	Outer	m	p	fm, fH	fH	h, p', Q	c	c	c, Cl
	Inner		P, m	c, P	c, P	c, 5P	P	c, 2P	c, 3P

*Setule-like process with membrane along one side, naked on other side.
#Setule-like process with membrane along both sides.

4. Kabata indicates (table, p. 215) that there are 2 spines on the first segment of the exopodite of thoracic legs II–IV although he figures only a single spine (figs. 2D–F). The Eniwetok specimens posses only a single spine on this segment in these legs.

5. Kabata indicates (table, p. 215) the presence of plumosities on the inner surface of the third segment of the exopodite of the third thoracic leg. The Eniwetok specimens did not exhibit this.

6. The Eniwetok specimens posses plumosities on the inner surface of the third segment of the endopodite of the fourth thoracic leg. These are not listed in the original description of *D. similis*.

Kabata also indicates (p. 213 and fig. 1H) that the "eye spots" are what the present author is comparing with the conspicilla of *Nesippus*. Kabata apparently failed to see the true ocular region lying below the

platelike area of heavy sclerotization situated between and immediately posterior to these processes.

Family Euryphoridae

Alebion gracilis Wilson

Figure 13

Alebion gracilis Wilson, 1905b, p. 128.—Lewis, 1966, p. 136, figs. 36–38.
For synonymy, see Lewis (1966).

Hosts and distribution.—See Lewis (1966).

Material.—4 males (USNM 120747) from the external surface of *Carcharinus menisorrah* (Müller and Henle); 2 females (USNM 120748) from the external surface of *C. menisorrah*.

Measurements (in mm).—2 females and 4 males:

		male	
	female	mean	range
Total length, excluding caudal setae	6. 66, 6. 55	3. 62	3. 52–3. 81
Length of cephalothorax	3. 81, 3. 59	2. 09	2. 04–2. 15
Width of cephalothorax	2. 89, 3. 07	2. 12	1. 92–2. 22
Length of genital segment	1. 63, 1. 66	0. 76	0. 70–0. 81
Width of genital segment	1. 96, 2. 00	0. 67	(all specimens)
Length of genital segment processes	1. 11, 1. 18		
Length of abdomen	0. 70, 0. 74	0. 56	0. 44–0. 67
Length of egg strings (nonovigerous)			

Description.—Male only (for description of female, see Lewis, 1966). Male cephalothorax (fig. 13*a*) ovoid, consisting of cephalon and first 4 thoracic segments. Frontal region slightly less than one-tenth the total length of cephalothorax, with narrow membrane along anterior margin; division between frontal region and rest of cephalothorax distinct. Lateral margins of cephalothorax smoothly convex, bearing narrow membrane. Posterior lateral region with small, semilunar concavity, concavity with fine, hairlike process. Posterior median cephalothoracic region terminating at level of posterior lateral regions, posterior margin flatly concave medially, posterior surface bearing approximately 5 spinules laterally. Posterior sinus U-shaped, with frilled membrane and shelflike projection extending medially from outer surface, second membrane extending posteriorly from posterior outer surface. Dorsal surface with major grooves forming irregular H, anterior longitudinal legs of H terminating lateral to distinct ocular region. Median dorsal surface with 3 pairs of spines situated between ocular region and cross bar of H formed by major dorsal grooves. Free fourth pedigerous segment short, length approximately one-third the width, dorsal surface with small, platelike lateral ex-

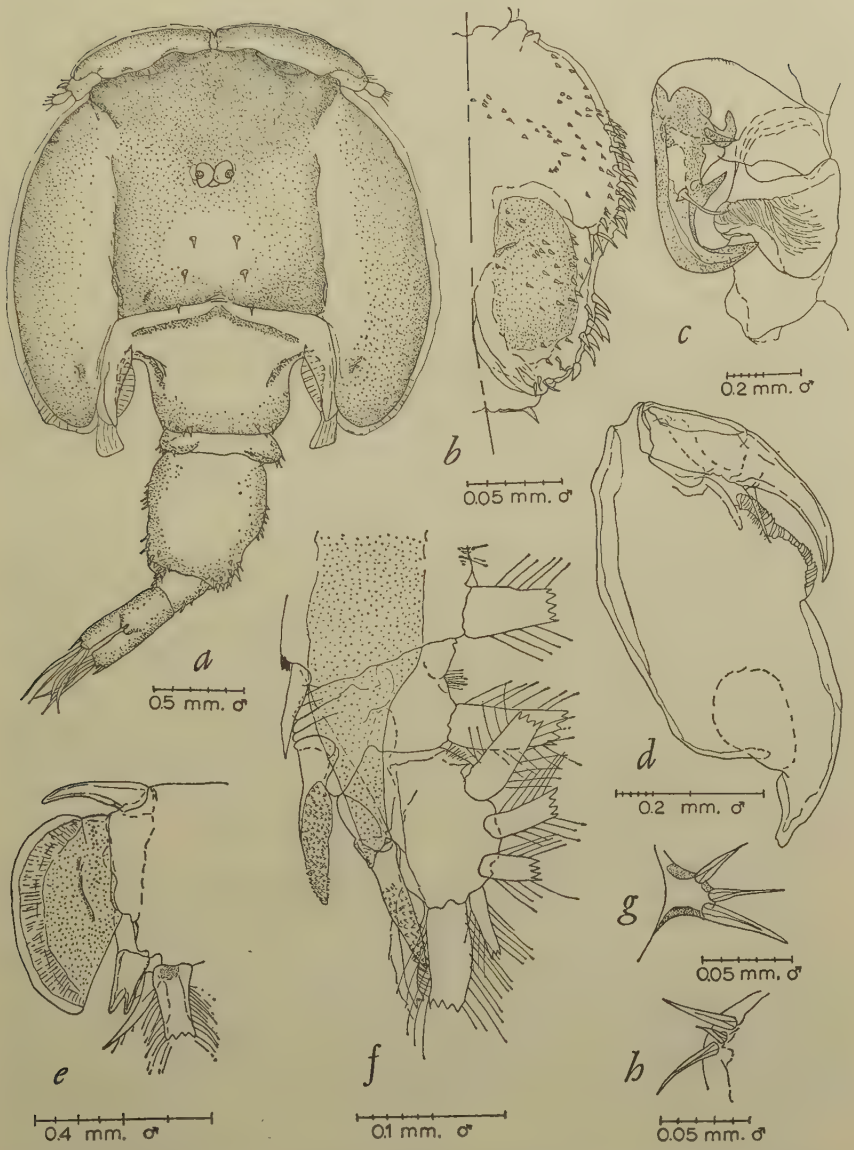


FIGURE 13.—*Alebion gracilis* Wilson, 1905, male: *a*, dorsal view; *b*, genital segment, ventral view; *c*, right antenna, ventral view; *d*, right maxilliped, ventral view; *e*, distal region of second segment of exopodite of right first thoracic leg, anterior view; *f*, exopodite of second thoracic leg, anterior view; *g*, right fifth leg, ventral view; *h*, right sixth leg, ventral view.

tensions, each with approximately 4 spinules posteriorly. Division between fourth pedigerous and genital segments distinct, complete.

Male genital segment (fig. 13*b*) with convex lateral margins anteriorly, tapered posteriorly. Anterior and posterior halves each with cluster of spinules and spines laterally. Posterior margin flat dorsally, bilobed ventrally. Fifth legs (fig. 13*g*) situated at break between anterior and posterior halves, consisting of node bearing 3 naked setules. Sixth legs (fig. 13*h*) situated on posterior end of lobe on ventral surface, consisting of 3 naked setules. Abdomen, 2-segmented, distinct from genital segment. First segment subrectangular, approximately five-eighths the length of second segment, medial lateral surfaces with cluster of spines and spinules. Second segment continuous with caudal rami, slightly wider posteriorly than anteriorly, anal indentation distinct. Caudal rami subrectangular plumose along distal inner surface. Rami bearing 3 plumose terminal setae, 1 plumose seta on lateral distal surface, and 2 plumose setules, first on distal inner surface, second just medial to outermost seta. Outer surface of rami with several minute spinules.

Male antennule similar to that of female although second segment approximately half the length of first, not one-third as in female. Antenna (fig. 13*c*) 3-segmented, situated posterior and medial to antennule base. First segment irregular, with ridgelike adhesion process proximally. Second segment clubshaped, with 2 knoblike adhesion processes on distal outer surface, anteriormost continuous with spikeshaped projection. Third segment continuous with clawlike terminal process, with node proximally bearing weakly sclerotized, spinelike projection; setulelike accessory process present at probable junction of segment and terminal process. Terminal process with secondary spine proximally.

Mandible, maxillule, maxilla, postantennal process and postoral process similar to those of female. Maxilliped (fig. 13*d*) 2-segmented, situated posterior and medial to maxilla base. First segment strongly developed, with narrow, somewhat recurved proximal articulation process. Distal inner surface of first segment with serrated ridge forming adhesion process. Second segment incompletely separable from clawlike terminal process, bearing setalike accessory process from distal inner surface.

Thoracic legs I–IV similar to those of female. Two major differences evident. Innermost terminal spine of second segment of exopodite of male first leg bifid (fig. 13*e*), female with simple spine. Spine on outer distal surface of second segment and spine on proximal outer surface of third segment of exopodite of male second thoracic leg (fig. 13*f*), with denticulations, not enlarged and hookshaped as in female.

Family Caligidae

Pseudanuretes pomacanthi, new species

Figures 14, 15

Material.—1 female (holotype, USNM 120749) from the gill cavity of *Pomacanthus imperator* (Bloch).

Measurements (in mm).—1 female:

Total length, excluding caudal setae	0.97
Length of cephalothorax	0.74
Width of cephalothorax	0.61
Length of fused genital segment and abdomen	0.23
Width of genital segment	0.31
Length of egg strings (strings broken)	

Description.—Cephalothorax (fig. 14*a*) consisting of cephalon and first 4 thoracic segments, anterior end bluntly pointed. Frontal region narrow, forming approximately one-sixteenth the length of cephalothorax, partially covered by adjacent portion of cephalothorax; with narrow membrane projecting from anterior ventral surface. Lateral surfaces of cephalothorax flatly convex, with fine, ventrally projecting membrane. Posterior lateral regions forming narrow, slightly projecting lobe, posterior sinus minute, without membrane. Posterior median cephalothoracic region broad, forming 90 percent of posterior surface, covering indistinct free fourth pedigerous segment and anterior end of genital segment. Major dorsal cephalothoracic grooves extending anteriorly from junction of posterior lateral and posterior median cephalothoracic regions, terminating on lateral surface in anterior third of cephalothorax; transverse groove absent. Ocular region distinct, situated well anterior to termination of dorsal grooves.

Free fourth pedigerous segment appearing as narrow annulus, indistinctly separable from cephalothorax but distinct from genital segment. Genital segment (fig. 14*b*) broad, lateral surfaces convex, posterior surface knobby, depressed medially. Fifth legs (fig. 15*f*) situated on posterior lateral surface, consisting of 4 plumose setules, 1 slightly anterior to other 3. Abdomen fused with genital segment, situated in posterior depression of segment. Anal opening distinct, between small caudal rami. Caudal rami (fig. 14*c*) short, bearing 4 plumose terminal setae.

Antennule (fig. 14*d*) 2-segmented, attached to cephalothorax immediately lateral to frontal region; segments flaccid, poorly sclerotized. First segment approximately one and one-half times the length of second, margins irregular, anterior ventral surface bearing approximately 13 naked or lightly plumose setae, distal ventral surface bearing

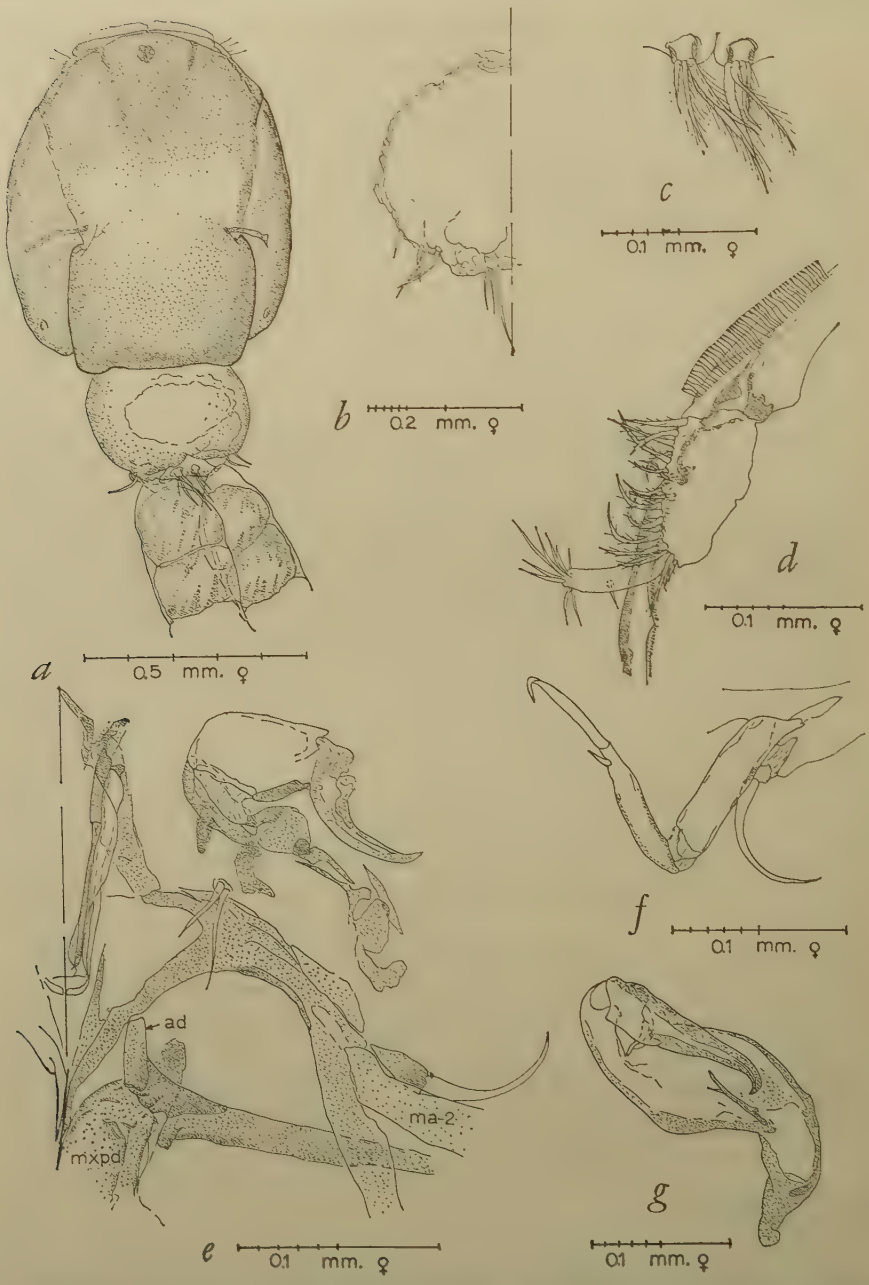


FIGURE 14.—*Pseudanuretes pomacanthi*, new species, female: *a*, dorsal view; *c*, caudal rami, same view. Ventral views: *b*, genital segment, right side; *d*, right antennule and adjacent section of frontal region; *e*, oral region, left side showing antenna, mouth cone, mandible, maxillule, maxilla base (ma–2), and associated processes, adhesion pad (ad), and maxilliped base (mxpd); *f*, left maxilla; *g*, left maxilliped.

3 setae. Second segment rodlike, with single naked setule from middle of segment, approximately 9 naked setules from distal surface. Antenna (fig. 14*e*) 3-segmented, situated posterior and slightly medial to antennule base. First segment generally ringshaped, heavily sclerotized, with spikelike projection from posterior surface. Second segment well developed, broader proximally than distally. Third segment and clawlike terminal process continuous, with knoblike articulation surface proximally and knoblike projection on medial inner surface; accessory processes not evident.

Mandible (fig. 14*e*) 4-parted, rodlike, distalmost part denticulated along inner margin. Postantennal process evident as small, lightly sclerotized area surrounded by ringlike area of heavy sclerotization situated lateral and posterior to antenna base, area with 3 nodule-like structures although "typical" hairlike processes not evident. Postoral process absent. Postoral adhesion pad present as barshaped projection of heavily sclerotized rod in sternal region, immediately anterior to maxilliped base. Maxillule (fig. 14*e*) minute, nodular, situated lateral and posterior to mouth cone, slightly posterior to antennal base. Nodule bearing 2 poorly sclerotized, naked setae. Maxilla (fig. 14*f*) 2-segmented, situated posterior and lateral to maxillule, adjacent to (though not associated with) large, naked seta (maxillary whip of Kabata, 1965b). First segment approximately one and one-fourth times the length of second, elongate, tapered to minutely bilobed proximal articulation process. Second segment elongate, with small, spikelike subterminal process and long, setalike terminal process.

Maxilliped (fig. 14*g*) 2-segmented, situated medial and slightly posterior to maxilla base. First segment well developed, proximal end narrow, recurved slightly. Second segment incompletely separable from clawlike terminal process, accessory process not evident. Sternal furca absent.

Thoracic legs I–III biramous although endopodite of first leg rudimentary, fourth thoracic leg uniramous, small, poorly sclerotized, 3-segmented. For nature and armature of thoracic legs, see figures 15*a–e* and table 6.

Discussion.—The female of *Pseudanuretes pomacanthi*, new species, differs from the females of the two other recognized members of the genus, *P. chaetodontis* Yamaguti (1936) and *P. fortipedis* Kabata (1965b) (for a note on *P. schmitti* Rangnekar, 1957, see below), in two respects:

1. The antenna is simple and does not have an accessory spine.
2. The structure and armature of the fourth thoracic leg. The leg of P. *pomacanthi* is similar in structure to that of *P. fortipedis* but has 2 terminal setae instead of 1 The leg of both species is either 2- or 3-segmented while that of P. *chaetodontis* is only 1-segmented.

Kabata (1965b, p. 30) questions the inclusion of *P. schmitti* Rangnekar (1957) in the genus *Pseudanuretes* because of the presence of postantennal processes as well as the apparent absence of a maxillary whip. Whether the species belongs to the genus *Pseudanuretes* or

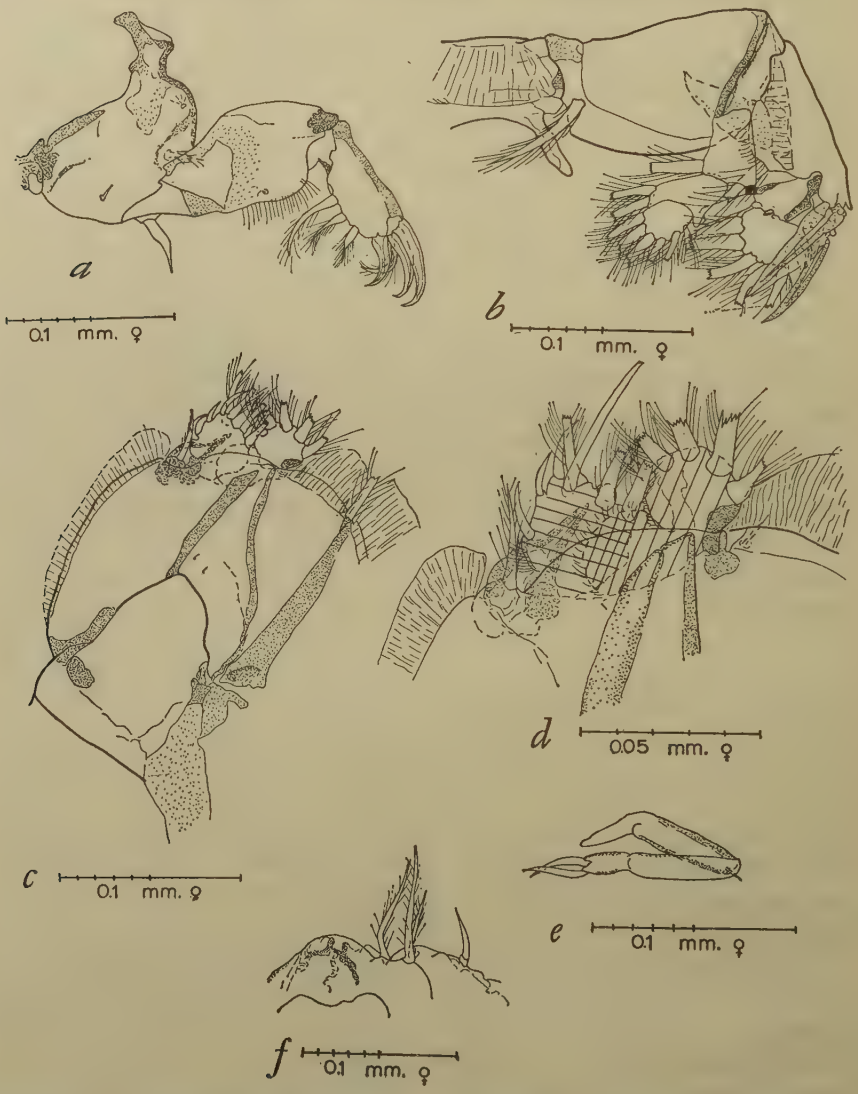


FIGURE 15.—*Pseudanuretes pomacanthi*, new species, female, thoracic legs: *a*, right first, posterior views; *b*, right second, anterior view; *c*, right third, posterior view; *d*, rami of right third, posterior view; *e*, left fourth, ventral view; *f*, right fifth, ventral view.

somewhere else can only be determined after the type material is reexamined.

There are several unique characteristics found in *P. pomacanthi* and, to some extent (reference to endopodite of second thoracic leg and to third thoracic leg), in *P. chaetodontis* (and presumably in *P. fortipedis*) which suggest a change from the general makeup of other caligids:

1. The second thoracic leg, which the present author believes is one of the more stable "elements" in caligids, lacks several armature elements in *P. pomacanthi* ("m," "p," and "s" on the protopodite; "c" on the inner surface of the second segment of the endopodite).
2. The third thoracic leg, which, in *P. pomacanthi* and *P. chaetodontis*

TABLE 6.—*Armature of thoracic legs I–IV of the female of* Pseudanuretes pomacanthi, *new species*

Leg	Surface	Interpodal Plate	Protopodite	Exopodite			Endopodite		
				1	2	3	1	2	3
I	Outer		sss, p		3H, P				
	Inner		p′	c	P, 2p				
II	Outer	m	fm	m, mH	H	H, Q, 3P	C		3P
	Inner		P	c, P	P	2P	P	2P	3P
III	Outer	m	m, p	H	c, 3h, P′		c	c, 3P	
	Inner		m, 2s		3P			2P	
IV	Outer				2p′				

(and *P. fortipedis*?), lacks the typical plumose seta (P) on the inner surface of the first segment of the endopodite.

3. Several accessory processes are apparently absent on two appendages (antenna, segment 3; maxilliped, segment 2).

These differences, collectively, are unique. They are, however, listed after the observation of only a single specimen of *P. pomacanthi* and a review of the literature of *P. chaetodontis* and *P. fortipedis*. A reexamination of the material of the previously named species and other material of the presently described species is needed to clarify the situation. Further, the degree of sclerotization of the various body parts in *P. pomacanthi* is, in general, much less than in many other caligids, making the interpretation of many parts (e.g., maxillule) difficult.

The name "*pomacanthi*" is derived from the host name *Pomacanthus*.

Anuretes serratus Shiino

Anuretes serratus Shiino, 1954b, p. 260, figs. 1–2.—Lewis, 1964a, p. 188, figs. 13–14.

HOSTS AND DISTRIBUTION.—See Lewis (1964a).

MATERIAL.—7 females and 1 male (USNM 120750) from the external surface of several specimens of *Naso vlamingi* (Valenciennes); 3 females and 2 males (retained by the author) from the external surface of several specimens of *N. vlamingi.*

MEASUREMENTS (in mm).—9 females, 3 males:

	female		
	mean	*range*	*male*
Total length, excluding caudal setae	2. 12	1. 98–2. 23	1. 67, 1. 67, 1. 69
Length of cephalothorax	1. 69	1. 64–1. 76	1. 30, 1. 30, 1. 26
Width of cephalothorax	1. 46	1. 39–1. 57	1. 19, 1. 19, 1. 15
Length of genital segment	0. 39	0. 31–0. 52	0. 36, 0. 34, 0. 31
Width of genital segment	0. 74	0. 63–0. 77	0. 38, 0. 43, 0. 40
Length of egg strings (egg strings broken)			

DESCRIPTION.—See Lewis (1964a).

Dentigryps litus Lewis

Dentigryps litus Lewis, 1964b, p. 362, figs. 9–11, 12*d,h,l,* 13*d.*—Kabata, 1965b, p. 19, fig. 1.

HOSTS AND DISTRIBUTION.—5 host records:

locality	*hosts*	*reference*
Eniwetok	*Plectropomus leopardus*	
	Epinephelus fuscoguttatus	
	Aulostomus chinensis	
	Balistoides viridescens	Lewis (1964b)
Queensland	*Cromileptes altivelis*	Kabata (1965b)

MEASUREMENTS AND DESCRIPTION.—See Lewis (1964b).

Lepeophtheirus plectropomi? Nunes-Ruivo and Fourmanoir

FIGURES 16–18

Lepeophtheirus plectropomi Nunes-Ruivo and Fourmanoir, 1956, p. 74, figs. 5, 6.—Kabata, 1966b, p. 565, fig. 2.

HOSTS AND DISTRIBUTION.—2 host records:

locality	*hosts*	*reference*
Madagascar	*Plectropomus maculatus*	Nunes-Ruivo and Fourmanoir (1956)
Australia	*Rachycentron canadus*	Kabata (1966b)

MATERIAL.—5 females (USNM 120751) from the external surface of *Epinephelus fuscoguttatus* (Forskål); 12 females and 1 male (retained by the author) from the buccal cavity of *Epinephalus kohleri* Schultz.

MEASUREMENTS (in mm).—16 females and 1 male:

	female		
	mean	*range*	*male*
Total length, excluding caudal setae	4. 69	4. 00–5. 07	2. 15
Length of cephalothorax	2. 78	2. 45–3. 15	1. 40
Width of cephalothorax	2. 58	2. 25–3. 00	1. 35
Length of genital segment	1. 06	0. 90–1. 22	0. 38
Width of genital segment	1. 26	1. 05–1. 52	0. 38
Length of abdomen	0. 43	0. 30–0. 56	0. 13
Length of egg strings (12 strings)	2. 66	1. 07–3. 85	

DESCRIPTION.—Female cephalothorax (fig. 16*a*) ovoid, consisting of cephalon and first 4 thoracic segments. Frontal region narrow, anterior surface with slight medial indentation, with narrow membranous flange; division between frontal region and remaining cephalothorax distinct medially, indistinct laterally. Lateral margins slightly irregular, basically convex, with narrow membranous flange. Posterior sinuses distinct, V–shaped, with small membrane projecting medially from outer lateral surface. Posterior medial surface of cephalothorax with short, necklike projection forming attachment surface for free fourth pedigerous segment; posterior medial region extending posteriorly to posterior lateral cephalothoracic region. Major dorsal cephalothoracic grooves forming irregular H, anterior portion of longitudinal grooves of H terminating slightly posterior and lateral to ocular region. Ocular region distinct, in anterior third of cephalothorax.

Free fourth pedigerous segment approximately twice as wide as long; posterior lateral region of tergum heavily sclerotized, giving platelike appearance. Division between fourth pedigerous and genital segments indistinct, incomplete. Genital segment (fig. 16*c*) wider than long, lateral margins broadly convex, posterior surface bilobed from dorsal viewpoint. Fifth legs (fig. 16*e*) situated on posterior lateral ventral surface, consisting of short, spikeshaped projection bearing 3 plumose setules dorsally, additional setule present just anterior to base of leg.

Abdomen 1-segmented, short, length approximately two-thirds the width. Segment swollen medially, narrower at both ends. Lateral posterior surfaces angled posteromedially, medial region bilobed, forming anal opening. Caudal rami small, subrectangular, distal inner surface plumose. Distal surface with 3 plumose setae and 2 setules, one on either side of group of setae, additional plumose seta present on medial outer surface of rami.

Cephalothorax of male (fig. 16*b*) similar to that of female. Heavily sclerotized regions of tergum of free fourth pedigerous segment not extending as far posteriorly as those of female although segments similar. Genital segment subovoid, with slight indentation in middle

of lateral surface, at origin of fifth legs. Fifth legs (fig. 16*f*) lobate, short, bearing 3 plumose setules, additional setule present just anterior to base of lobe. Sixth legs (fig. 16*g*) lobate, approximately twice the size of fifth legs, situated on posterior ventral surface of genital segment, bearing 3 plumose setules. Abdomen 1-segmented,

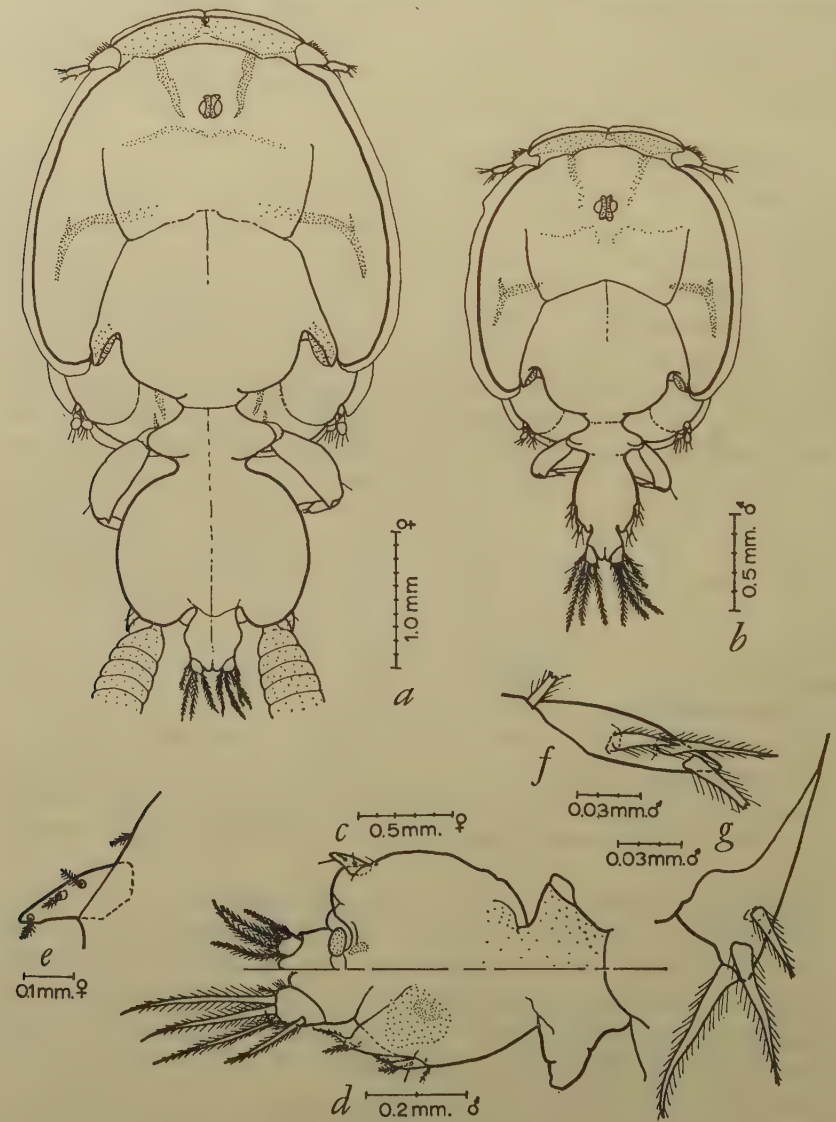


FIGURE 16.—*Lepeophtheirus plectropomi*? Nunes-Ruivo and P. Fourmanoir, 1956, dorsal views; *a*, female; *b*, male. Ventral views: *c*, female genital segment and fifth leg; *d*, male genital segment, fifth, and sixth legs. Legs, ventral views: *e*, female fifth; *f*, male fifth; *g*, male sixth.

short, length and width about equal, flared slightly towards posterior end. Caudal rami as in female.

Female and male antennule (fig. 17*a*) 2-segmented, first segment strongly developed, approximately one and one-half times the length of second. Irregular articulation surfaces on proximal end of first

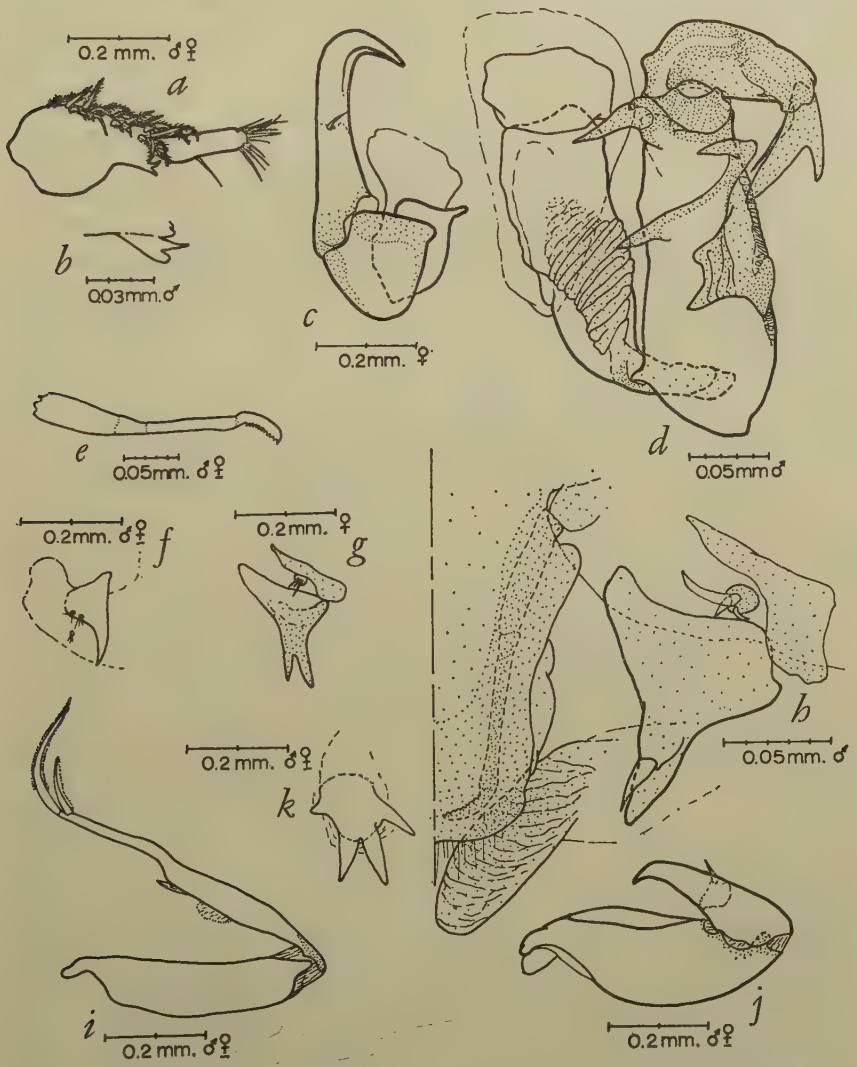


FIGURE 17.—*Lepeophtheirus plectropomi*? Nunes-Ruivo and P. Fourmanoir, 1956, ventral views (except *b*): *a*, left antennule; *b*, process on distal posterior surface of first segment of male antennule; *c*, female left antenna; *d*, male right antenna; *e*, left mandible; *f*, post-antennal process; *g*, female left maxillule and postoral process; *h*, male oral region, showing mouth cone, mandible, maxillule, postoral process, and postoral adhesion pad; *i*, left maxilla; *j*, left maxilliped.

segment articulating on platelike process extending posteriorly from frontal region, terminating in cephalothorax posterior to frontal region. Anterior ventral and anterior lateral surfaces of first segment bearing 24 plumose setae and setules, bifurcate process (fig. 17*b*) present on posterior edge of distal surface. Second segment elongate, bearing single naked seta from middle of posterior surface, 12 naked setae from distal surface. Female antenna (fig. 17*c*) 3-segmented, situated posterior and medial to antennule base. First segment broad, irregular, bearing spikelike projection on inner posterior surface. Second segment short, well developed. Third segment and terminal process indistinctly separable or continuous, clawlike, seta-like accessory process present at indistinct junction of segment and terminal process. Male antenna (fig. 17*d*) 3-segmented, positioned as in female. First segment elongate, with large adhesion surface ventrally; length of second segment approximately the same as first, segment well developed, with several irregular, spikelike projections and 2 adhesion surfaces, one on anterior medial region, second on broad, irregular projection of inner medial region. Third segment distinct from bifurcate terminal process, bearing single seta-like accessory process on inner surface, at junction of segment and terminal process.

Mandible of female and male (fig. 17*e*) 4-parted, rodlike, distalmost part curved inward, flattened, bearing 11–12 denticulations. Female and male postantennal process (fig. 17*f*) situated lateral and slightly posterior to antenna base, consisting of spikelike projection and 3 nodules, each bearing several hairlike processes. Two nodules present on base of spikelike projection, third situated immediately posterior to base. Female postoral process (fig. 17*g*) consisting of bifurcate projection immediately posterior to maxillule, male process (fig. 17*h*) spikeshaped, with poorly sclerotized accessory spine from distal half of inner ventral surface. Female and male maxillule (figs. 17*g,h*) consisting of nodule bearing 3 seta-like processes. Female and male maxilla (fig. 17*i*) 2-segmented, situated lateral and slightly posterior to postoral process. Both segments elongate, first approximately four-fifths the length of second. Rodlike second segment with 2 membranes on medial inner surface (one folded, appearing spinelike) and 2 saber-like terminal processes, innermost slightly more than twice the length of outer, with frilled membrane along both margins, outermost process with frilled membrane on outer margin only. Male with lobate postoral adhesion surface (fig. 17*h*), surface similar to adhesion surface on first segment of antenna although plates not as distinct.

Maxilliped of female and male (fig. 17*j*) 2-segmented, situated posterior and medial to maxilla base. First segment strongly developed, length slightly more than one and one-half times that of combined

second segment and terminal process. Second segment continuous with clawlike terminal process, bearing single, seta-like accessory process on inner surface, at junction of segment and terminal process. Female and male sternal furca situated between and slightly posterior

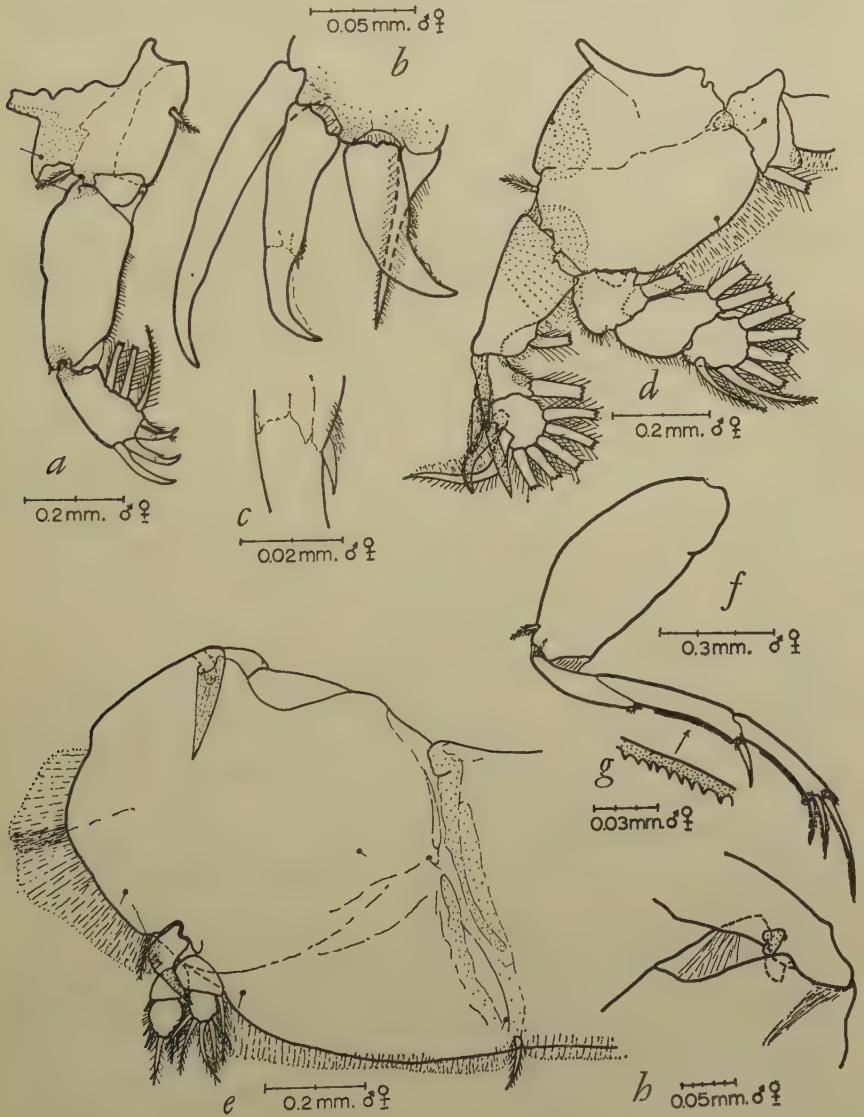


FIGURE 18.—*Lepeophtheirus plectropomi*? Nunes-Ruivo and P. Fourmanoir, 1956, thoracic legs, anterior views: *a*, right first; *b*, distal region of second segment of exopodite of first; *c*, portion of median terminal spine of second segment of exopodite of first; *d*, right second; *e*, right third; *f*, right fourth; *g*, enlarged portion of denticulated region of fourth· *h*, joint of protopodite and first segment of exopodite of fourth.

to maxilliped bases, tines angled outward slightly, bluntly pointed distally. Basal region of furca with lateral projection on each side, length of projections variable although projection on left usually longer than that on right.

Thoracic legs I–III biramous although endopodite of first leg rudimentary, fourth thoracic leg uniramous, 4-segmented. For nature of appendages and armature, see figures 18*a–j* and table 7.

Discussion.—The identification of the Eniwetok specimens as *L. plectropomi* is questioned for three reasons:

1. The incomplete original description makes identification difficult.

2. The rami of the sternal furca of the Eniwetok specimens are thinner than those figured for *L. plectropomi.*

3. The membrane on the inner 2 terminal spines on the second segment of the exopodite of the first thoracic leg is figured as reaching

Table 7.—*Armature of thoracic legs I–IV of the female and male of* Lepeophtheirus plectropomi? *Nunes-Ruivo and Fourmanoir, 1956*

Leg	Surface	Interpodal plate	Protopodite		Exopodite			Endopodite		
			1	2	1	2	3	1	2	3
I	Outer		s,p		rh	3mH,P				
	Inner		p		c	3P				
II	Outer	m		m,p	m,mH	mH	2mH,Q,2P	c	c	c,3P
	Inner		s,P	m,s	c,P	c,P	c,3P	P	c,2P	c,3P
III	Outer*	m	m,s,P		3s,H	c,p′	c,3p′,P	c	c,3P	
	Inner		s,P,m,s		P	c,P	c,3P	P	c,3P	
IV	Outer		p		fh	d,fH	d,3fH			

*Several hairlike processes on protopodite not included.

the distal end of the spines (fig. 5*b* in Nunes-Ruivo and Fourmanoir, 1956). The condition in the Eniwetok specimens differs, as shown in figures 18*b, c.*

Both Nunes-Ruivo and Fourmanoir (1956) and Kabata (1966) compare *L. plectropomi* with *L. dissimulatus* Wilson (1905). The two species are similar in general body composition but exhibit appendage and other body characteristics that enable them to be readily separated. Two of these characteristics are:

1. The female of *L. plectropomi* possesses a short, spinelike projection as part of the fifth leg. The female of *L. dissimulatus* does not; the fifth leg of this species includes a setule-bearing lobe or node but not a spine.

2. The antenna of the adult male of *L. plectropomi* (providing the Eniwetok specimens are members of this species) has several spinelike projections on the second segment. The antenna of the adult male of *L. dissimulatus* does not have these. The only projecting process on the antenna of this species is a dactyliform adhesion process that usually is wrapped around the distal portion of the segment.

Lepeophtheirus dissimulatus Wilson

Lepeophtheirus dissimulatus Wilson, 1905, p. 631, pl. 22.—Lewis, 1964a, p. 178, figs. 11, 12.

HOSTS AND DISTRIBUTION.—See Lewis (1964a, 1967).

MATERIAL.—1 female (USNM 120752) from the gill cavity of *Parupeneus cyclostomus?* (Lacépède).

MEASUREMENTS (in mm).—1 female:

Total length, excluding caudal setae	2. 38
Length of cephalothorax	1. 75
Width of cephalothorax	1. 62
Length of genital segment	0. 58
Width of genital segment	0. 83
Length of abdomen	0. 14
Length of egg string (1 string)	1. 75

DESCRIPTION.—See Lewis (1964).

Pseudocaligus similis, new species

FIGURES 19–21

MATERIAL.—1 female (holotype, USNM 120753) from the gill cavity of *Fistularia petimba* Lacépède; 1 male (allotype, USNM 120754) from the gill cavity of *F. petimba;* 1 male (paratype, USNM 120755) from the gill cavity of *F. petimba;* 7 females (2 damaged) (paratypes, USNM 120756) from the buccal cavity of *F. petimba;* 8 females and 5 males (retained by author) from the gill cavity of *F. petimba.*

MEASUREMENTS (in mm).—14 females, 5 males:

	females		*males*	
	mean	*range*	*mean*	*range*
Total length, excluding caudal setae	6. 13	5. 44–6. 81	4. 36	3. 92–4. 77
Length of cephalothorax	2. 18	1. 92–2. 41	2. 22	2. 11–2. 41
Width of cephalothorax	1. 79	1. 48–2. 00	1. 92	1. 70–2. 11
Length of genital segment	1. 81	1. 44–2. 07	0. 87	0. 74–1. 00
Width of genital segment	1. 36	0. 96–1. 78	0. 69	0. 59–0. 78
Length of abdomen	1. 78	1. 44–2. 00	0. 87	0. 78–0. 96
Length of egg string (16 strings)	4. 23	2. 96–5. 00		

DESCRIPTION.—Female cephalothorax (fig. 19*b*) ovoid, consisting of cephalon and first 4 thoracic segments. Frontal region approximately one-eleventh the total length of cephalothorax, anterior surface bilobed, with membranous margin; division between frontal region and remaining cephalothorax incomplete. Lunules (fig. 19*g*) distinct, extending posteriorly, on ventral surface, to posterior portion of frontal region. Lateral cephalothoracic margins irregular, with narrow membrane extending laterally, second membrane extending medially, on ventral surface. Posterior lateral regions lobate, with small, socket-like depression. Posterior sinus (fig. 19*e*) distinct, semi-V-shaped, with fine membrane on outer surface. Posterior median cephalothoracic region extending slightly past lateral regions, posterior margin irregular. Major dorsal cephalothoracic grooves forming irregular H, anterior legs of H terminating in narrow bands of heavy sclerotization. Ocular region distinct, just anterior to anterior end of H-shaped groove system.

Female free fourth pedigerous segment distinct from cephalothorax, indistinctly separable from genital segment. Approximate length slightly more than two-thirds the width, lateral margins irregularly convex. Genital segment (fig. 19*d*) elongate, irregularly tapered anteriorly, lateral posterior surface lobate. Fifth legs (fig. 21*g*) situated on posterior lateral surface, consisting of 4 plumose setules, 2 from nodule, remaining 2 arising from surface of genital segment adjacent to nodule.

Female abdomen elongate, 2-segmented, indistinctly separable from genital segment. First segment more than 4 times the length of second, lateral margins irregular; second segment with flatly convex lateral margins, posterior surface concave laterally, bilobed medially, at anal indentation. Caudal rami (fig. 19*f*) attached to concave lateral posterior surface of second segment of abdomen, shape subrectangular, with small convex projection on distal inner surface. Armature consisting of 2 plumose setules from distal outer surface, 3 plumose setae from outer distal surface, single plumose setule from inner distal surface, and plumosities on convex projection of distal inner surface.

Male cephalothorax (fig. 19*a*) similar to that of female. Free fourth pedigerous segment slightly more than twice as wide as long, distinct from both cephalothorax and genital segment. Genital segment (fig. 19*c*) wider anteriorly than posteriorly, lateral margins flatly convex in anterior half, flatly concave in posterior half; dorsal posterior surface projecting posteriorly slightly past junction of genital segment and abdomen. Fifth legs (fig. 21*h*) situated on middle of lateral ventral surface, consisting of nodule bearing 3 plumose setules. Sixth legs (fig. 21*i*) situated on posterior ventral surface, slightly anterior

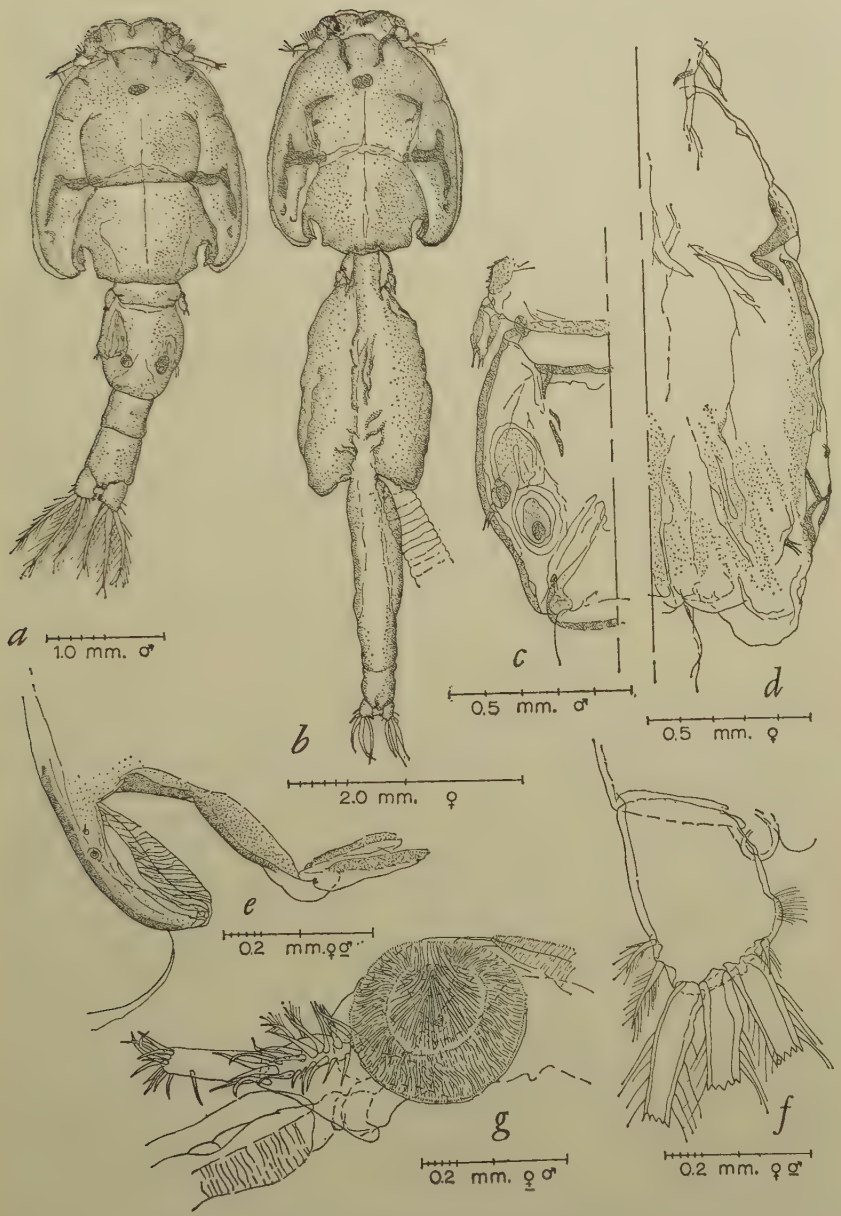


FIGURE 19.—*Pseudocaligus similis*, new species: *a*, male, dorsal view; *b*, female, dorsal view; *c*, male fourth pedigerous and genital segments, ventral view; *d*, female, same; *e*, posterior cephalothoracic sinus, dorsal view; *f*, right caudal ramus, ventral view; *g*, right lunule and antennule (see text for differences between female and male), ventral view.

to genital opening, consisting of 2 plumose setules. Abdomen distinct from genital segment, 2-segmented, first segment approximately three-fourths the length of second, both segments subrectangular. Caudal rami similar to those of female although small convex projection on distal inner surface more distinct in male.

Female antennule (fig. 19*g*) 2-segmented, attached to lateral posterior ventral surface of frontal region and adjacent ventral surface of cephalothorax. First segment slightly less than twice the length of second, broad proximally, tapered toward slightly constricted distal end, anterior ventral and anterior surface bearing 24 naked and lightly plumose setae and setules. Second segment rodlike, with single naked setule from middle of posterior surface, approximately 11 naked setules from distal surface. Male antennule similar to that of female except second segment longer, first segment only 1.4 times the length of second. Female antenna (fig. 20*b*) 3-segmented, situated posterior and medial to antennule base. First segment short, distal surface subtriangular, inner posterior surface with small, spikelike projection. Second segment short, slightly wider proximally than distally. Third segment continuous with clawlike terminal process, bearing 2 setule-like accessory processes, 1 proximally, 1 medially. Male antenna (figs. 20*a*,*c*) 3-segmented, first segment longer than that of female, spikelike projection minute. Second segment longer than that of female, with one adhesion pad on proximal inner surface, another forming ridgelike projection from distal posterior surface. Third segment short, suborbicular, distinct from short, beakshaped terminal process, bearing 2 setule-like accessory processes, 1 on either side of terminal process.

Female and male mandible (figs. 20*a*,*b*) rodlike, 4-parted, distalmost part flattened, curved inward, inner margin with 12 denticulations. Female and male maxillule (figs. 20*a*,*b*) palplike, situated posterior and slightly lateral to mandible base, with naked terminal setule and seta. Female and male maxilla (fig. 20*d*) 2-segmented, situated posterior and lateral to maxillule. First segment slightly less than half the length of second, with spikeshaped projection from inner proximal surface; segment curved inward slightly toward distal end. Second segment elongate, with small, membranous, subconical projection from distal half of inner surface, distal surface bearing 2 seta-like processes, innermost slightly less than twice the length of outermost, with fine membrane along inner surface, outer terminal process with fine membrane along outer margin.

Female postantennal process (fig. 20*b*) situated posterior and slightly lateral to antenna base, consisting of 3 nodules bearing several hairlike processes and short, spikeshaped projection originating from round, heavily sclerotized plate. Anterior 2 nodules situated on plate, third

located slightly posterior and medial to plate. Plate and projection of male postantennal process (fig. 20*a*) much larger, projection falciform, process bearing nodules present on plate of female not visible on male, nodule posterior to plate of female present on male. Female and male postoral process (figs. 20*a*,*b*) spikeshaped, situated slightly posterior to maxillule base. Postoral adhesion pads present in male (figs. 20*a*,*f*) although not rugose, consisting of pair of heavily sclerotized, U-shaped ridges on median longitudinal axis slightly posterior to maxilla bases.

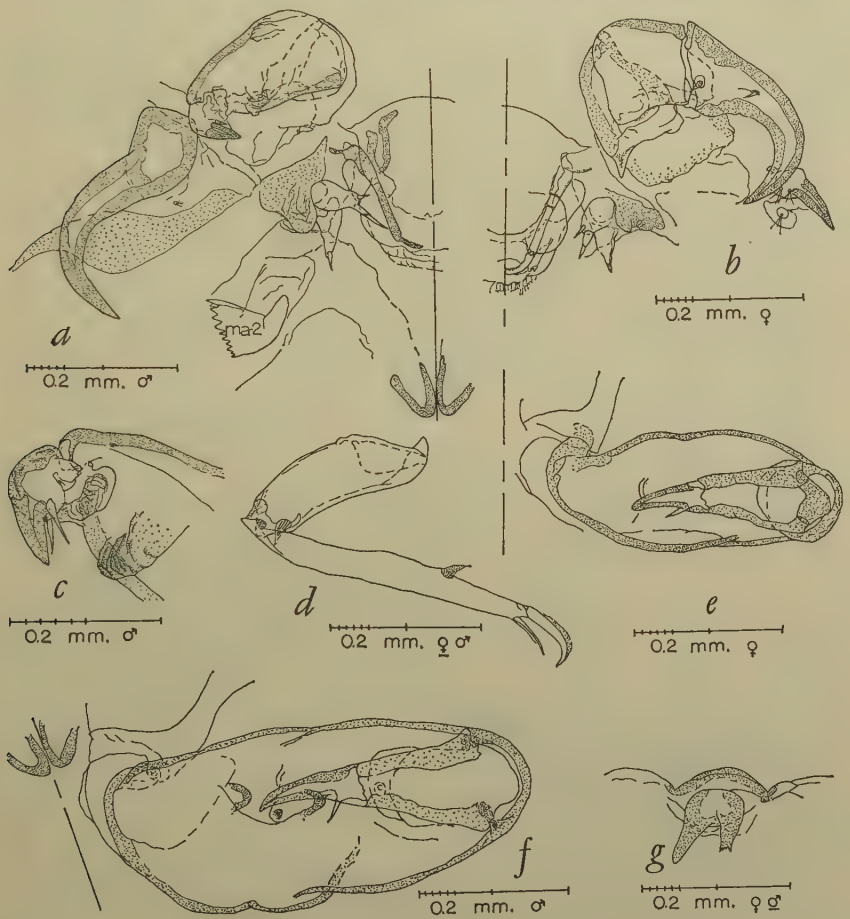


FIGURE 20.—*Pseudocaligus similis*, new species, ventral views: *a*, oral region of male, showing antenna, mouth cone, mandible, maxillule, maxilla base (ma–2), postantennal process, postoral process, and postoral adhesion pad; *b*, same of female (postoral adhesion pads missing in female); *c*, third segment and distal region of second segment of right antenna of male; *d*, right maxilla; *e*, female left maxilliped; *f*, male postoral adhesion pads and left maxilliped; *g*, sternal furca.

Female maxilliped (fig. 20*e*) 2-segmented, situated posterior and medial to maxilla base. First segment strongly developed, with small, ridgelike projection on medial inner surface. Second segment distinct from clawlike terminal process; inner surface longer than outer, with setulelike accessory process distally. Male maxilliped (fig. 20*f*) similar

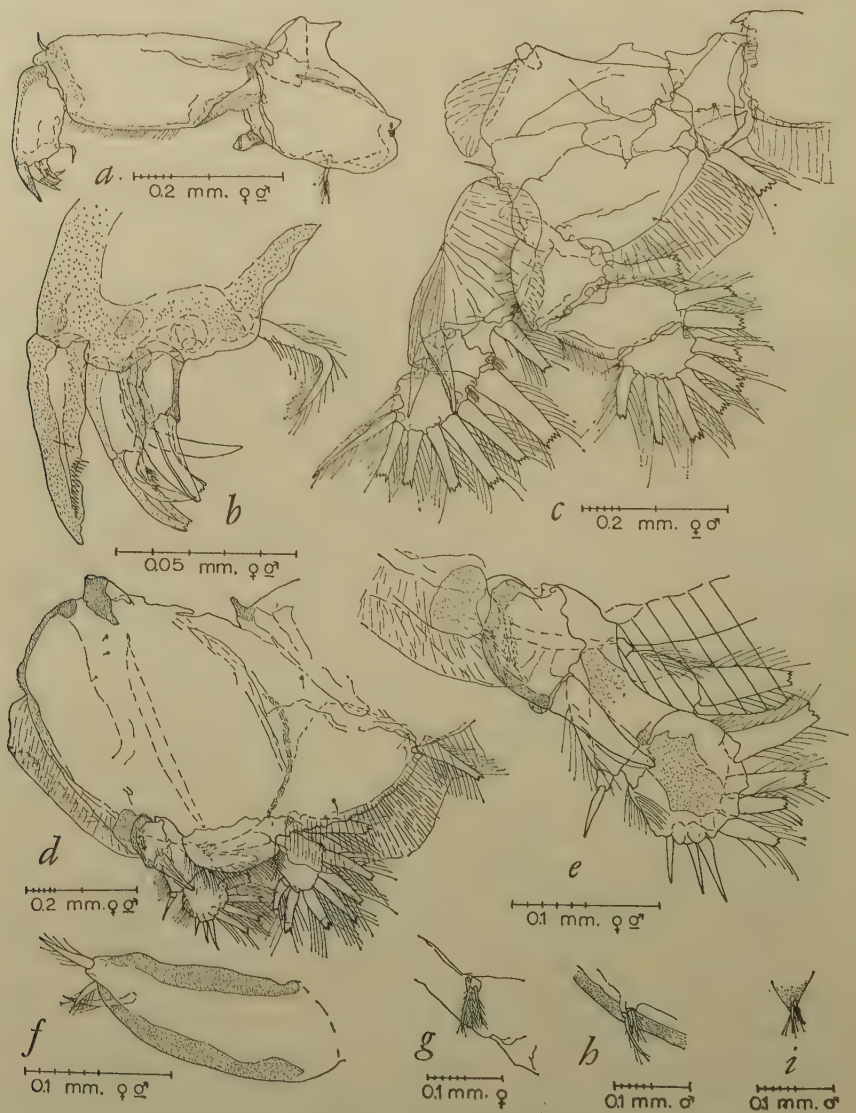


FIGURE 21.—*Pseudocaligus similis*, new species, right thoracic legs, anterior views (except *f*): *a*, first; *b*, distal region of second segment of exopodite of first; *c*, second, *d*, third, *e*, exopodite of third; *f*, left fourth (posterior view). Right legs, ventral views: *g*, female, fifth; *h*, male, fifth; *i*, male, sixth.

to that of female although larger and first segment bearing 3 knoblike projections adjacent to ridge described for female. Sternal furca (fig. 20*g*) U-shaped, associated with trilobate platelike structure posterior to maxilliped bases; tines of furca sharply rounded distally.

For nature and armature of thoracic legs I–IV, see figures 21*a–f* and table 8. Second segment of exopodite of first thoracic leg with only single plumose setule on inner surface. Pair of padlike structures present posterior to interpodal plate of first thoracic leg.

DISCUSSION.—*Pseudocaligus similis* most closely resembles *P. fistulariae* Pillai (1961) and *P. tenuicauda* Shiino (1964), both of which are also found on *Fistularia*. The similarities are not only in the overall body shape (especially the elongate, 2-segmented abdomen in the female and the shorter 2-segmented abdomen in the male) but also in

TABLE 8.—*Armature of thoracic legs I–IV of the female and male of* Pseudocaligus similis, *new species*

Leg	Surface	Interpodal plate	Protopodite		Exopodite			Endopodite		
			1	2	1	2	3	1	2	3
I	Outer		p		p′	2dH,H,P′				
	Inner		p		c	p				
II	Outer	m		m,p	m,mH	mH	rh,H,Q	c,c	c	c,3P
	Inner		ss,P	m,s	c,P	c,P	c,5P	P	c,2P	c,3P
III	Outer	m	r,m,p		m,mH	c,p′	c,3p′	c	c,2P	
	Inner*		ss,P,s,m,s		c,P	c,P	c,4P	P	c,4P	
IV	Outer#		3p							

*Elements in middle of protopodite not tabulated.
#Elements not to be definitively associated with protopodite, status of segments obscure.

the appendages, especially the male antenna. The fifth leg of both *P. tenuicauda* and *P. similis* is, however, 1-segmented while that of *P. fistulariae* is distinctly 2-segmented and has a plumose setule on the distal surface of the first segment. *Pseudocaligus similis* can be most readily distinguished from *P. tenuicauda* by 3 characteristics:

1. The maxillule is better developed in *P. similis* and, in this respect, resembles the condition figured for *P. fistulariae*.

2. The 3 terminal spines on the second segment of the exopodite of the first thoracic leg are described as being bifid in *P. tenuicauda* while only the inner 2 spines are bifid in *P. similis* although the armature of the spine can give a pseudobifid appearance in unstained specimens.

3. The size of the terminal seta on the second segment of the exopodite of the first thoracic leg differs between the 2 species, being large in *P. tenuicauda* and small in *P. similis*.

The species name is derived from the Latin word for "like" or "resembling" and alludes to the similarity of *P. similis* to *P. tenuicauda* and *P. fistulariae*.

Caligus coryphaenae Steenstrup and Lütken

Caligus coryphaenae Steenstrup and Lütken, 1861, p. 360, pl. 4, fig. 7.—Lewis, 1967, p. 101. figs. 37–39.

HOSTS AND DISTRIBUTION.—See Lewis (1967).

MATERIAL.—4 females and 2 males from the external surface of *Euthynnus yaito* (Jordon and Evermann); 4 females and 1 male from the external surface of *Sarda orientalis* (Schlegel); 1 male from the external surface of *Grammatorcynus bilineatus* (Rüppell); 2 females from the external surface of *Caranx melampygus*? Cuvier and Valenciennes; 7 females and 1 male from the external surface of *Katsuwonus pelamis* (Linnaeus). (All specimens retained by author.)

MEASUREMENT (in mm).—15 females, 5 males:

	females		*males*	
	mean	*range*	*mean*	*range*
Total length, excluding caudal setae	4. 76	4. 51–6. 36	3. 99	3. 55–4. 77
Length of cephalothorax	2. 71	2. 48–3. 33	2. 60	2. 37–3. 00
Width of cephalothorax	2. 28	2. 04–2. 96	1. 97	1. 81–2. 37
Length of genital segment	1. 13	0. 96–1. 33	0. 64	0. 59–0. 85
Width of genital segment	1. 25	1. 11–1. 52	0. 86	0. 78–1. 07
Length of abdomen	0. 90	0. 70–1. 33	0. 61	0. 52–0. 74
Length of egg strings (13 strings)	4. 67	4. 22–5. 70		

DESCRIPTION.—See Lewis (1967).

REMARKS.—The size of the Eniwetok specimens is less than that of the specimens described from Hawaii. The reasons for this difference warrant further study. One possible source for the reasons may be that the specimens were all taken from fishes captured in the atoll lagoon; no host specimens were available from the open ocean outside the lagoon.

Caligus productus Dana

Caligus productus Dana, 1853, p. 1354, pl. 94 (fig. 4).—Lewis, 1967, p. 116, figs. 43–45.

HOSTS AND DISTRIBUTION.—See Lewis (1967).

MATERIAL.—2 females (USNM 120759) from the gill cavity of *Sarda orientalis* (Schlegel); 1 female and 2 males from the gill cavity and buccal cavity of *S. orientalis;* 5 females and 2 males from the gill cavity and buccal cavity of *S. orientalis*.

MEASUREMENTS (in mm).—6 females, 3 males:

	females		males
	mean	*range*	
Total length, excluding caudal setae	4. 54	4. 29–4. 92	4. 00, 3. 81, 3. 74
Length of cephalothorax	1. 86	1. 78–1. 96	1. 96, 1. 81, 1. 81
Width of cephalothorax	1. 64	1. 48–1. 85	1. 74, 1. 48, 1. 48
Length of genital segment	1. 49	1. 37–1. 70	1. 00, 0. 81, 0. 81
Width of genital segment	1. 10	1. 00–1. 18	0. 70, 0. 59, 0. 67
Length of abdomen	1. 12	0. 96–1. 26	0. 85, 0. 74, 0. 78
Length of egg strings (2 strings)		2. 96, 3. 03	

DESCRIPTION.—See Lewis (1967).

Caligus bonito Wilson

Caligus bonito Wilson, 1905a, p. 589, pl. 13, figs. 150–153, text figs. 5, 12–15, 29, 30, 35, 37, 38, 40–45.—Lewis, 1967, p. 124, figs. 46–48.

HOSTS AND DISTRIBUTION.—See Lewis (1967).

MATERIAL.—2 females from the gill cavity and buccal cavity of *Sarda orientalis* (Schlegel) (specimens retained by author).

MEASUREMENTS (in mm).—2 females:

Total length, excluding caudal setae	4.66, 5.55
Length of cephalothorax	2.11, 2.48
Width of cephalothorax	2.04, 2.48
Length of genital segment	1.52, 1.48
Width of genital segment	1.33, 1.22
Length of abdomen	0.96, 1.11

DESCRIPTION.—See Lewis (1967).

Caligus asymmetricus Kabata

Caligus asymmetricus Kabata, 1965c, p. 110, figs. 1B,D,E.—Lewis, 1967, p. 131, figs. 49–51.

HOSTS AND DISTRIBUTION.—See Lewis (1967).

MATERIAL.—4 females (one damaged) and 4 males (USNM 120762) from the external surface, gill cavity and buccal cavity of *Grammatorcynus bilineatus* (Rüppell); 2 males (retained by author) from the external surface of *Sarda orientalis* (Schlegel); 2 females (retained by author) from the gill cavity of *Grammatorcynus bilineatus* (Rüppell); 1 male (retained by author) from the buccal cavity of *G. bilineatus*.

MEASUREMENTS (in mm).—5 females and 7 males:

	females		males	
	mean	*range*	*mean*	*range*
Total length, excluding caudal setae	3.05	2.72–3.51	2.78	2.35–3.15
Length of cephalothorax	1.69	1.49–1.94	1.74	1.51–2.00
Width of cephalothorax	1.42	1.31–1.53	1.38	1.28–1.48
Length of genital segment	0.89	0.76–0.99	0.54	0.41–0.70
Width of genital segment	0.80	0.63–0.95	0.51	0.45–0.56
Length of abdomen	0.33	0.29–0.36	0.36	0.31–0.41

DESCRIPTION.—See Lewis (1967).

REMARKS.—Based on the examination of the Eniwetok material and a comparison of this material with the Hawaiian specimens (USNM 112912, 112913), two additions should be made to the description in Lewis (1967):

1. There are 2 adhesion processes on the male antenna, the first (op. cit., p. 136) is a ridged, lappet-like adhesion pad on the distal inner surface of the second segment while the second (not previously described) extends, as a narrow band, from the proximal anterior surface to the distal inner surface of the second segment. This adhesion band is more distinct in the Eniwetok specimens than in those from Hawaiian fishes.

2. The positioning of the denticulations shown on the second segment of the endopodite of the second thoracic leg in Lewis (1967, fig. 51*c*) is incorrect for the appendage in situ. For detailed examination and camera lucida drawings, the thoracic legs are normally removed and mounted under 9 mm cover slips. This technique frequently causes the arrangement of the denticulations on the second segment of the endopodite of the second thoracic leg to be distorted. In the appendage in situ, on both Hawaiian and Eniwetok specimens, the denticulations are typically arranged in pairs (except for the single proximalmost denticulation), straddling the outer surface of the segment (as shown in Kabata, 1965*c*, fig. 1E).

Caligus ligatus Lewis

Caligus ligatus Lewis, 1964a, p. 164, figs. 8–9; 1967, p. 163, figs. 62–64.

HOSTS AND DISTRIBUTION.—6 host records:

locality	*hosts*	*reference*
Hawaiian Islands	*Acanthurus dussumieri*	
	Naso hexacanthus	Lewis (1964a)
	Dascyllus albisella	
	Aulostomus chinensis	
	Holocentrus xantherythrus	
	Pranesus insularum?	Lewis (1967)

MATERIAL.—7 females and 3 males (USNM 120764) from the buccal cavity of *Holocentrus spinifer* (Forskål); 14 females and 4 males from the buccal cavity of *H. spinifer* (retained by author).

MEASUREMENTS (in mm).—19 females, 6 males:

	female		*male*	
	mean	*range*	*mean*	*range*
Total length, excluding caudal setae	3.42	2.92–3.85	2.56	2.22–2.89
Length of cephalothorax	1.63	1.37–1.89	1.43	1.22–1.59
Width of cephalothorax	1.55	1.33–1.67	1.27	1.11–1.48
Length of genital segment	1.06	0.89–1.22	0.49	0.41 0.59
Width of genital segment	0.95	0.78–1.15	0.43	0.37–0.52
Length of abdomen	0.54	0.44–0.63	0.42	0.37–0.52
Length of egg strings (8 strings)	2.49	2.33–2.78		

DESCRIPTION.—See Lewis (1964a, 1967).

Caligus kapuhili Lewis

Caligus kapuhili Lewis, 1967, p. 152, figs. 57–59.

HOSTS AND DISTRIBUTION.—2 host records:

locality	*host*	*reference*
Hawaiian Islands	*Chaetodon miliaris*	
	Chaetodon fremblii	Lewis (1967)

MATERIAL.—2 females (USNM 120768) from the gill cavity of *Chaetodon auriga* Forskål; 2 males (USNM 120768) from the gill cavity of *Chaetodon lunula* (Lacépède).

MEASUREMENTS (in mm).—2 females and 2 males:

	female	*male*
Total length, excluding caudal setae	1. 94, 1. 87	1. 51, 1. 42
Length of cephalothorax	1. 06, 1. 10	0. 94, 0. 92
Width of cephalothorax	1. 04, 0. 90	0. 90, 0. 90
Length of genital segment	0. 56, 0. 40	0. 29, 0. 31
Width of genital segment	0. 52, 0. 49	0. 29, 0. 27
Length of abdomen	0. 20, 0. 20	0. 14, 0. 18
Length of egg strings (strings broken or missing)		

DESCRIPTION.—See Lewis (1967).

Caligus confusus? Pillai

FIGURES 22, 23

Caligus confusus Pillai, 1961, p. 104, fig. 10.—Kirtisinghe, 1964, p. 68, figs. 70, 71.
Caligus alalongae (not Krøyer).—Kirtisinghe, 1937, p. 435, figs. 1–4.—Yamaguti, 1954, p. 379, pl. 2 (fig. 19), pl. 3 (fig. 21).

?*Caligus constrictus* (not Heller).—Wilson, 1937a, p. 25, pl. 3, figs. 3a–i; 1937b p. 428, fig. 1.—Shiino, 1959a, p. 285, figs. 9, 10.

HOSTS AND DISTRIBUTION.—7 host records:

locality	*host*	*reference*
Trivandrum, South India	*Caranx sansun*	Pillai, 1961
Panama, Ecuador	*Elagatis bipinnulatus*	
	Caranx hippos	Wilson, 1937a
Panama	*Coryphaena hippurus*	Wilson, 1937b
Costa Rica	*Seriola*? species	Shiino, 1959a
Celebes	*Elagatis* species	
	Caranx species	Yamaguti, 1954
Ceylon	several species of carangids	Kirtisinghe, 1964

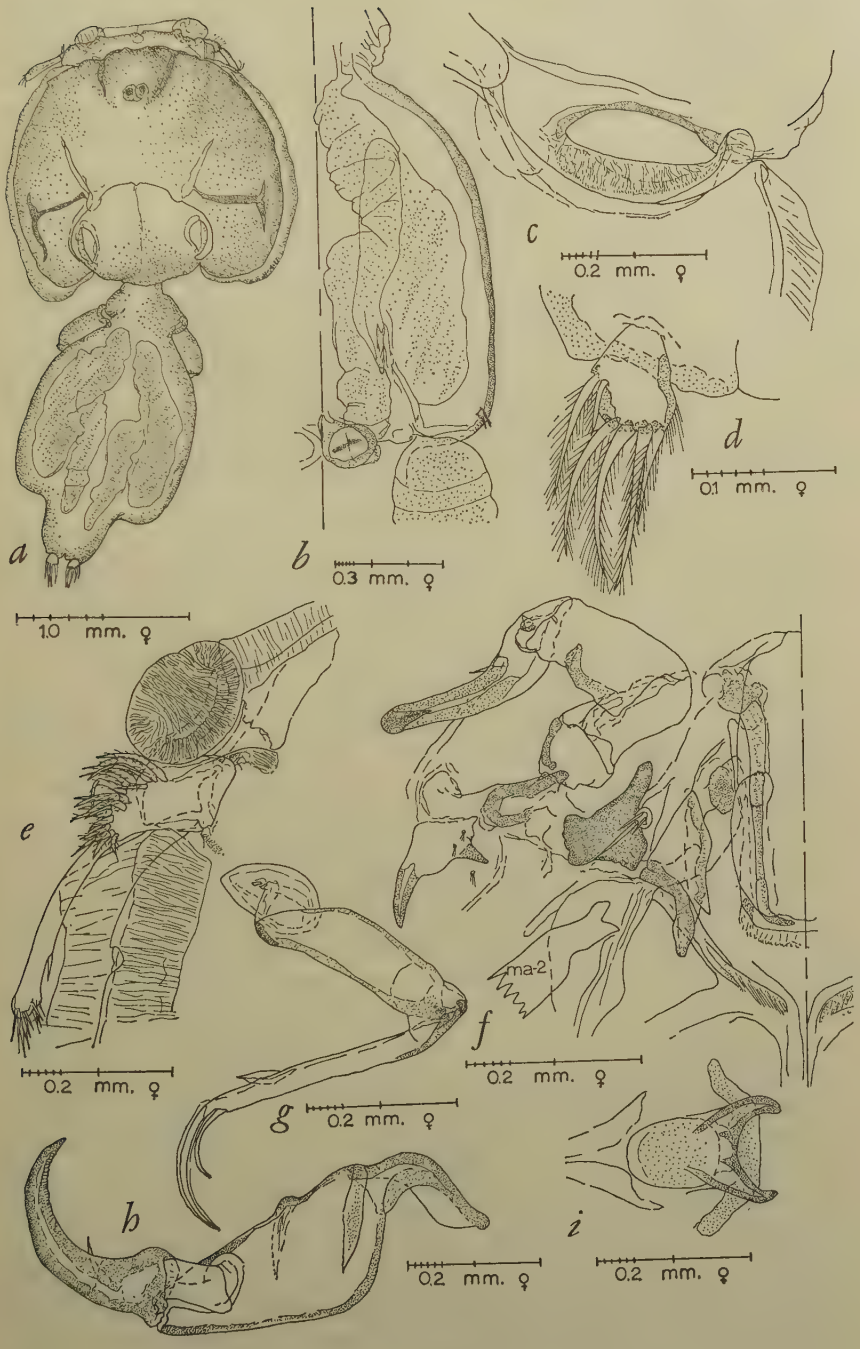
MATERIAL.—17 females and 1 immature male (probably late chalimus) (USNM 120763) from the buccal cavity of *Caranx melampygus* Cuvier and Valenciennes.

MEASUREMENTS (in mm).—16 females, 1 immature male:

	female		
	mean	*range*	*male*
Total length, excluding caudal setae	3. 22	2. 70–3. 44	2. 14
Length of cephalothorax	1. 49	1. 24–1. 57	1. 33
Width of cephalothorax	1. 57	1. 33–1. 67	1. 13
Length of genital segment	1. 19	0. 92–1. 31	0. 41
Width of genital segment	0. 98	0. 83–1. 08	0. 29
Length of abdomen	0. 46	0. 31–0. 56	0. 27
Length of egg string (11 strings)	2. 19	1. 57–3. 33	

DESCRIPTION.—Female only. Cephalothorax (fig. 22*a*) ovoid, consisting of cephalon and first 4 thoracic segments. Frontal region approximately one-twelfth the length of rest of cephalothorax, with median indentation; membrane normally projecting from leading edge of frontal margin in caligids much heavier in *C. confusus*, appearing as extension of frontal region. Lunules (fig. 22*e*) well developed, projecting anteriorly slightly past anteriormost portion of frontal region, projecting posteriorly, on ventral surface, to junction of frontal region and cephalothorax. Division between frontal region and remaining areas of cephalothorax distinct, with saddle-like median section. Lateral surface of cephalothorax slightly irregular, ventral portion with fine, laterally projecting membrane and second, medially projecting membrane. Indentation present in posterior lateral cephalothoracic region of many caligids here present indistinctly, as slight concavity on lateral surface, without normally associated hairlike process or processes.

FIGURE 22.—*Caligus confusus*? Pillai, 1961, female: *a*, dorsal view; *c*, posterior cephalothoracic sinus, same view. Ventral views: *b*, genital segment and part of egg string; *d*, right caudal ramus; *e*, right lunule and antennule; *f*, oral region, showing antenna, mouth cone, mandible, maxillule, maxilla base (ma–2), postantennal process, and postoral process; *g*, left maxilla; *h*, left maxilliped; *i*, sternal furca.


a
b
0.3 mm. ♀
c
0.2 mm. ♀
d
0.1 mm. ♀
1.0 mm. ♀
e
0.2 mm. ♀
ma-2
f
0.2 mm. ♀
g
0.2 mm. ♀
h
0.2 mm. ♀
i
0.2 mm. ♀

Posterior sinus (fig. 22*c*) distinct, frequently closed posterly; outerior margin bearing fine membrane, dorsal cephalothoracic surface adjacent to anterior and inner surfaces of sinus with minute, ridgelike roughenings. Posterior surface of median cephalothoracic region projecting slightly past posterior surfaces of lateral cephalothoracic regions, division between free fourth pedigerous segment and cephalothorax distinct. Major dorsal cephalothoracic grooves forming irregular H, anterior legs terminating well posterior to distinct ocular region present on median longitudinal axis of body, in anterior third of cephalothorax.

Free fourth pedigerous segment subtriangular, anterior region narrowest; medial constriction evident in some specimens, not in others; fourth pedigerous and genital segments fused. Genital segment (fig. 22*b*) narrow anteriorly, broad posteriorly, lateral margins strongly convex anteriorly, almost parallel posteriorly. Fifth leg (fig. 23*g*) situated on ventral posterior surface, consisting of slight swelllng bearing nodule with 3 plumose setules. Genital segment and abdomen fused.

Abdomen 1-segmented, broad anteriorly, narrower posteriorly, lateral margins flatly convex. Caudal rami (fig. 22*d*) attached to posterior ventral surface of abdomen, paddle-shaped, distal inner surface plumose. Distal surface of rami bearing 3 plumose setae and 1 plumose setule, additional plumose seta and setule present on slight indentation of middle of outer lateral surface.

Antennule (fig. 22*e*) 2-segmented, attached to knoblike cuticular projection of lateral anterior ventral surface of cephalothorax. First segment subrectangular, approximately two-thirds the length of second segment, anterior ventral and anterior surfaces with 21 naked or lightly plumose setules and setae; second segment rodlike, with naked setule from distal third of posterior surface, 11 naked setules from distal surface. Antenna (fig. 22*f*) 3-segmented, situated posterior and medial to antennule base. First segment flattened, irregular in outline; second segment subrectangular, with small, subtriangular projection from outer anterior surface. Third segment and terminal process indistinctly separable, clawlike, with setule-like accessory process medially, at junction of segment and terminal process; additional, lobate process present on proximal portion of segment.

Mandible (fig. 22*f*) rodlike, 4-parted, distalmost part flattened, curved inward, with 12 denticulations along inner surface. Postantennal process (fig. 22*f*) situated posterior and lateral to antenna base, consisting of plate bearing posteriorly directed spine and shorter, medially directed spine; 3 nodules present, 2 on plate, third slightly posterior to plate, all with several hairlike processes. Postoral process (fig. 22*f*) with broad base, irregularly tapered to bifid distal end, innermost tine approximately one-third the length of outer. Maxillule

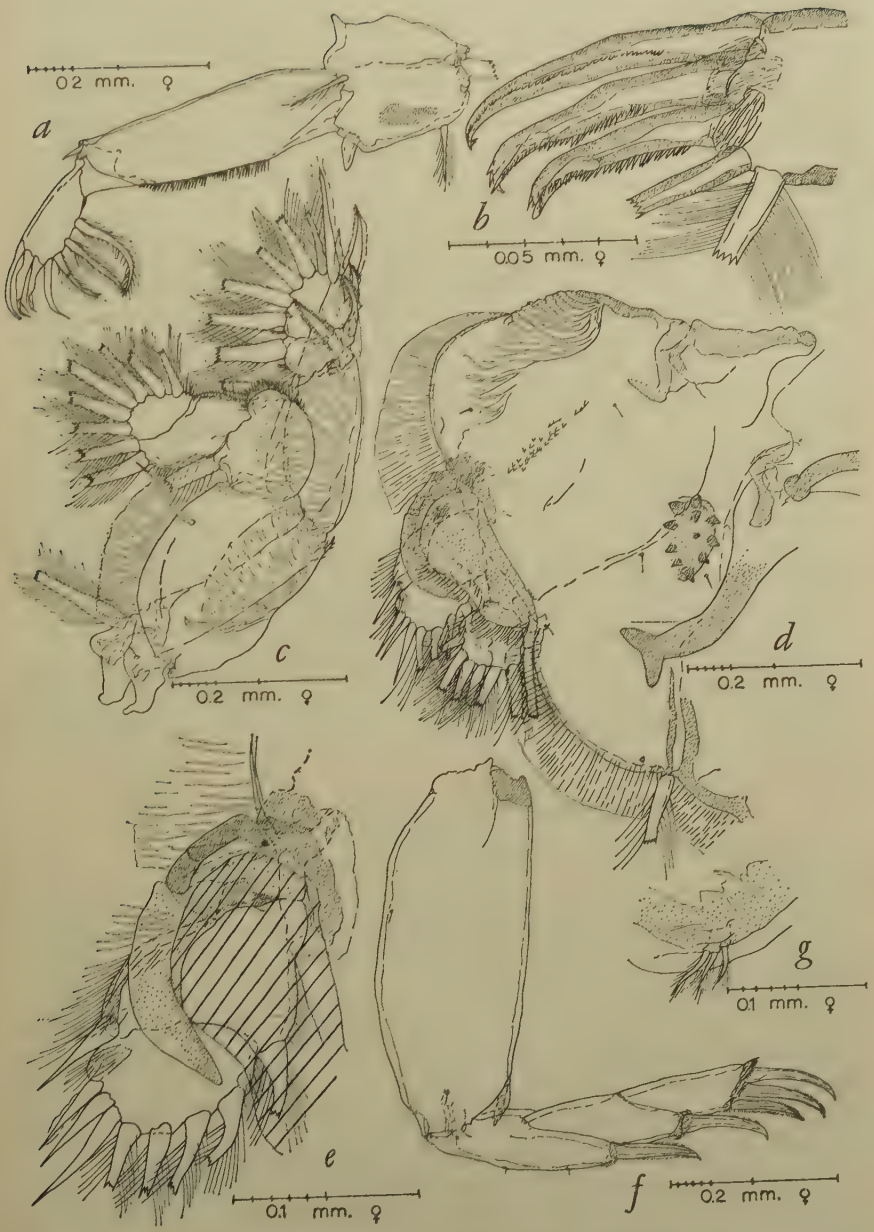


FIGURE 23.—*Caligus confusus*? Pillai, 1961, female, right thoracic legs, anterior views: *a*, first; *b*, distal region of second segment of exopodite of first; *c*, second; *d*, third, *e*, exopodite of third; *f*, fourth. Left fifth leg: *g*, ventral view.

(fig. 22*f*) nodular, situated lateral and slightly posterior to mandible base, bearing single naked seta and 2 naked setules. Maxilla (fig. 22*g*) 2-segmented, situated lateral and slightly posterior to maxillule. First segment approximately four-fifths the length of second, tapered proximally and distally to articulation surface. Second segment rodlike with U-shaped membrane on distal half of inner surface; distal surface with 2 saber-shaped processes, innermost approximately one and one-half times the length of outermost, both with fine membranes along outer and inner margins. Postoral adhesion pads (fig. 22*f*) evident as V-shaped ridges of heavy sclerotization adjacent to median longitudinal axis of body, slightly posterior to maxilla bases.

Maxilliped (fig. 22*h*) 2-segmented, situated posterior and slightly medial to maxilla base. First segment strongly developed, inner

TABLE 9.—*Armature of thoracic legs I–IV of the female of* Caligus confusus? *Pillai, 1961*

Leg	Surface	Interpodal Plate	Protopodite		Exopodite			Endopodite		
			1	2	1	2	3	1	2	3
I	Outer		p		m, rh	3dH				
	Inner		p, r*		C, C	3P, P′				
II	Outer	m		m, p	m, dmH	dmH	dmH, Z#, Q	C	c	c, 3P
	Inner		s, P	m, p′	c, P	c, P	c, 5P	P	c, 2P	3P
III	Outer	m	a, m, p		H	c, p′, s	c, 3p′, P	c	c, 2P	
	Inner		D, 2s, P, s, m, s			c, P	c, 3P	P	4P	
IV	Outer		p		fm, mH	fm, mH	3fm, 2mH, H			

*Roughened by minute projections giving brushlike appearance to element.
#Spine with simple membrane on one side, frilled membrane on other.

proximal half with heavily sclerotized transverse ridge; additional small, knoblike projection present on posterior surface (not shown on figure). Second segment and incompletely separable terminal process clawlike, segment with setule-like accessory process. Sternal furca (fig. 22*i*) situated between and slightly posterior to maxilliped bases, tines angled outward, sinus between tines broad.

Thoracic legs I–III biramous although endopodite of first leg reduced; fourth leg uniramous. For nature and armature of legs, see figures 22*a-f* and table 9.

DISCUSSION.—The Eniwetok specimens differ from Pillai's figures and description of *Caligus confusus* (1961) in two respects:

1. Pillai figures a membrane-like structure around the major spine on the postantennal process, another around the major spine on the

postoral process, and one on the outer margin of each ramus of the sternal furca. The Eniwetok specimens do not have any of these membranes although the edge of these structures is thin and semi-transparent and unless closely examined, gives a membrane-like appearance.

2. Pillai figures a blunt secondary projection on the proximal inner portion of the postoral process that is not present on the Eniwetok specimens.

The identification of the Eniwetok material as *C. confusus* Pillai is questioned because of the two differences mentioned above and the absence of an adequate first description of the species.

Both Pillai (1961) and Kirtisinghe (1964) list Wilson's (1937a,b) and Shiino's (1959a) *"Calligus constrictus"* as a synonym of *C. confusus* because of the very similar morphology of the figured specimens. There are some differences in the morphology that could be considered to be of a minor nature (e.g., shape of the postoral process), but there is a difference in the size of the specimens that should be evaluated with sufficient material. Pillai's female specimen(s) are 2.9 mm while Shiino's are 3.75 mm and Wilson's 5.0 mm in length. Even the female specimen(s) of Kirtisinghe (1964), from Ceylon, measure 4.5 mm in length, more than 1.5 times the length of Pillai's specimen(s) from southern India. Because of the difference in size, as well as the other characteristics, it is felt that there is some question (as noted in the synonymy) about the inclusion of Wilson's and Shiino's material and perhaps even that of Kirtisinghe.

Caligus pseudokalumai, new species

FIGURES 24, 25

MATERIAL.—1 female (holotype, USNM 120765) from the external surface of *Gymnosarea nuda* Günther.

MEASUREMENTS (in mm).—1 female:

Total length, excluding caudal setae	2. 89
Length of cephalothorax	2. 04
Width of cephalothorax	1. 48
Length of genital segment	0. 81
Width of genital segment	0. 89
Length of abdomen	0. 19
Length of egg strings (strings broken)	

DESCRIPTION.—Cephalothorax (fig. 24*a*) ovoid, consisting of cephalon, maxilliped-bearing and first 3 pedigerous segments. Frontal region approximately one-ninth the length of cephalothorax, anterior surface with narrow membrane. Lunules (fig. 24*e*) continuous with membrane along anterior margin, extending posteriorly, on ventral surface, to junction of frontal region and rest of cephalothorax. Lateral edge of

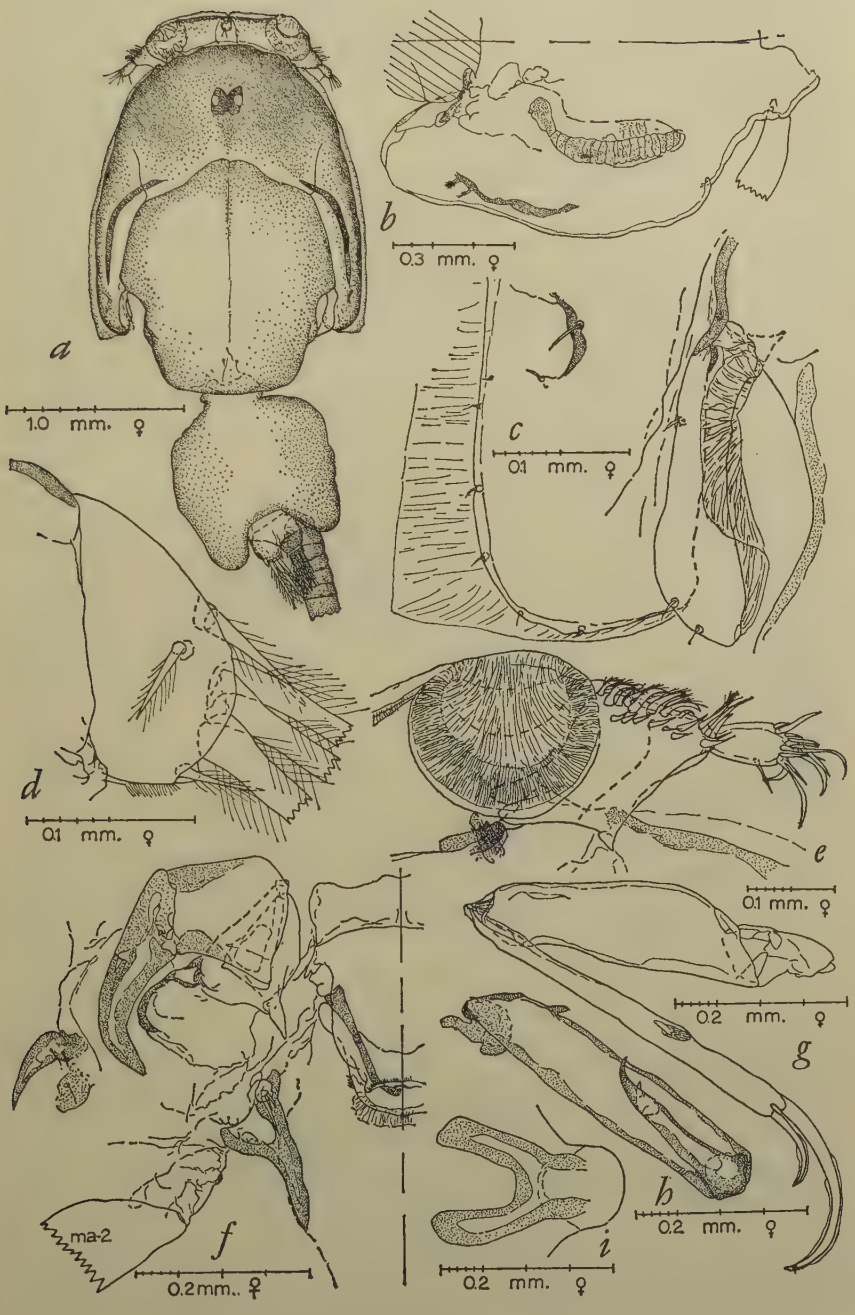
cephalothorax smooth, with slight indentation in anterior third, bearing narrow membrane and several hairlike processes. Posterior lateral region with small, cupshaped indentation. Posterior sinus (fig. 24*c*) distinct, anterior end sharply angled, lateral margins flatly concave, outer lateral surface bearing filmy membrane. Posterior median region of cephalothorax extending posteriorly well past lateral regions, posterior margin flatly convex in dorsal view; pair of minute, hairlike projections present, slightly anterior to posterior margin. Major dorsal cephalothoracic grooves forming irregular H, posterior legs flatly convex, anterior flatly concave, cross groove extending anteriorly from junction with legs of H. Ocular region distinct, in anterior fourth of cephalothorax.

Free fourth pedigerous segment distinct from cephalothorax although anterior half overlapped by posterior median cephalothoracic region. Fourth pedigerous and genital segments fused dorsally and ventrally. Surfaces of genital segment (fig. 24*b*) irregular; anterior region of segment broad, posterior bilobed, lobes extending posteriorly to caudal rami. Fifth legs (fig. 25*g*) situated on ventral surface, at beginning of posterior lobes, consisting of 2 nodules, anteriormost bearing single, lightly plumose setule, posterior bearing 2 plumose setules.

Abdomen 1-segmented, distinct from genital segment, lateral margins smooth, posterior margin V-shaped, almost covered by proximal surface of caudal rami. Caudal rami (fig. 24*d*) broad, lobate, width almost twice the greatest length. Inner surface plumose, distal surface bearing 3 plumose setae; inner distal surface with 1 plumose setule, distal outer surface with 2 plumose setules.

Antennule (fig. 24*e*) 2-segmented, attached to lateral posterior ventral surface of frontal region and adjacent surface of cephalothorax. First segment of general parallelogram shape, anterior and anterior ventral surface with 21 naked and lightly plumose setae and setules. Second segment clubshaped, length slightly less than two-thirds the length of anterior surface of first segment, with single naked seta from distal half of posterior surface, 13 naked setae from distal surface. Antenna (fig. 24*f*) 3-segmented, situated posterior and medial to antennule base. First segment squat, irregular, with narrow, daggerlike projection from posterior surface. Second segment slightly broader proximally than distally, distal surface irregular. Third segment and terminal process continuous, clawlike, with small, setule-like accessory process on proximal inner surface, second on medial surface.

FIGURE 24.—*Caligus pseudokalumai*, new species, female: *a*, dorsal view; *c*, posterior cephalothoracic sinus, same view. Ventral views: *b*, fourth pedigerous and genital segments; *d*, left caudal ramus; *e*, left lunule and antennule; *f*, oral region, showing antenna, mouth cone, mandible, maxillule, maxilla base (ma–2), postantennal, and postoral processes; *g*, right maxilla; *h*, right maxilliped; *i*, sternal furca.


a
1.0 mm. ♀
b
0.3 mm. ♀
c
0.1 mm. ♀
d
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e
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g
0.2 mm. ♀
h
0.2 mm. ♀
i
0.2 mm. ♀
f
ma-2
0.2mm.. ♀

Mandible (fig. 24*f*) rodlike, 4-parted, distalmost part curved inwards, inner surface with 12 denticulations. Postantennal process (fig. 24*f*) situated posterior and lateral to antenna base, consisting of heavily sclerotized clawlike projection with 2 nodules proximally, third present just posterior to base of projection; nodules each bearing single, large, hairlike process. Postoral process (fig. 24*f*) dagger-like, immediately adjacent to maxillule. Maxillule (fig. 24*f*) situated lateral and slightly posterior to mouth cone base, consisting of node bearing 2 short and one long seta-like projections. Maxilla (fig. 24*g*) 2-segmented, situated lateral and slightly posterior to maxillule. First segment slightly more than three-fourths the length of second, proximal articulation and muscle attachment surface directed at sharp angle to axis of segment. Second segment rodlike, bearing small, horsehoe-shaped membrane from medial inner surface and 2 saber-shaped terminal processes. Inner terminal process approximately twice the length of outer, both with fine membrane along inner and outer surfaces.

Maxilliped (fig. 24*h*) small, 2-segmented, situated posterior and slightly medial to maxilla base. First segment narrow, with small, spikelike projection from proximal posterior surface. Second segment rodlike, distinct from short, clawlike terminal process, with setule-like accessory process on distal inner surface. Sternal furca (fig. 24*i*) situated on median longitudinal axis of body posterior to maxilliped bases. Basal region of furca subconical, tines flattened, chisel-shaped distally.

Thoracic legs I–III biramous although endopodite of first leg rudimentary. Fourth thoracic leg uniramous, 3-segmented. For nature and armature of legs, see figures 25*a–f* and table 10.

Discussion.—*Caligus pseudokalumai* most closely resembles *C. kalumai* Lewis (1964a) recorded from *Acanthurus guttatus* from the Hawaiian Islands. The relatively minor differences between the two species include the following:

1. The cephalothorax is more elongate in *C. pseudokalumai,* and the posterior median cephalothoracic region projects posteriorly past the posterior lateral cephalothoracic regions more than twice as far as it does in *C. kalumai* (0.36 mm to 0.16 mm). As a percent of the length of the cephalothorax, this equals 12 and 9 respectively.

2. The postantennal and postoral processes as well as the sternal furca are bulkier and more heavily sclerotized in *C. kalumai.* Even with this, however, the 3 nodules associated with the postantennal process each bears a single large (in comparison with other species of the genus), hairlike process (not 2 as stated in Lewis, 1964a, p. 175) as do those in *C. pseudokalumai.*

3. The first segment of the endopodite of the second thoracic leg bears a tuft of plumosities in *C. kalumai* but does not in *C. pseudo-*

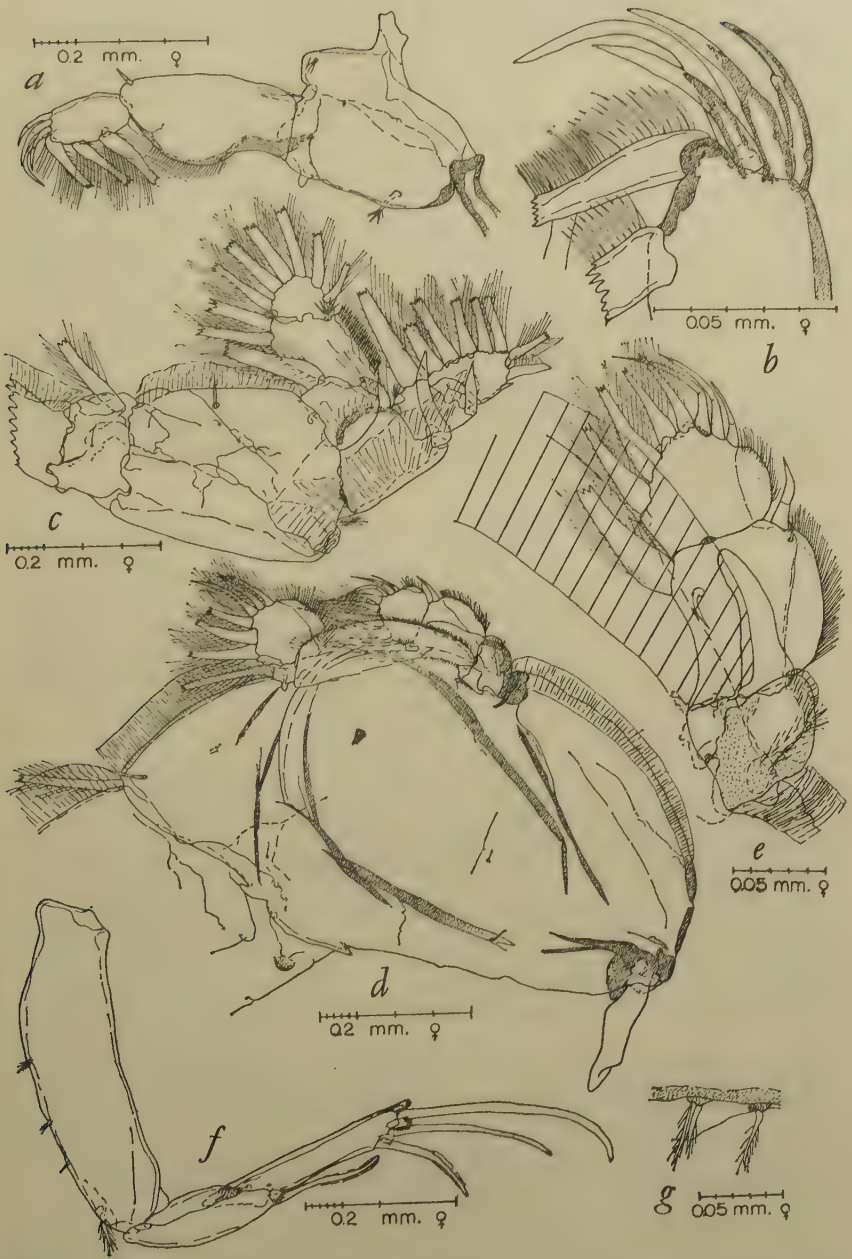

FIGURE 25.—*Caligus pseudokalumai*, new species, female, right thoracic legs, anterior views: *a*, first; *b*, distal region of second segment of exopodite of first; *c*, second; *d*, third; *e*, exopodite of third; *f*, fourth. Left fifth leg; *g*, ventral view.

kalumai. The plumosities on the outer margin of the second and third segments of the endopodite are heavier in *C. pseudokalumai* than in *C. kalumai*.

4. The first segment of the exopodite of the fourth leg bears a filamentous (or slightly denticulated) membrane at the base of the spine in *C. pseudokalumai* which is missing in *C. kalumai*.

With one possible exception, these do not appear to be gross differences and the apparent close relationship between the two species should be more closely examined when larger collections are available. The single difference that may be of a relatively gross nature is the tuft of plumosities (or their absence) on the first segment of the endopodite of the second thoracic leg. This is the easiest characteristic to use in separating the two species and, because of the relatively stable nature of the second thoracic leg, may indicate more divergence than is presently believed.

TABLE 10.—*Armature of thoracic legs I–IV of the female of* Caligus pseudokalumai, *new species*

Leg	Surface	Interpodal Plate	Protopodite		Exopodite			Endopodite		
			1	2	1	2	3	1	2	3
I	Outer		sss, p		rh	3H, P′				
	Inner		p		c	3P				
II	Outer	m		m, p	m, mH	mH	rh, mH, Q		C	C, 2P
	Inner		s, P	m, s	c, P	c, P	5P	P	c, 2P	c, 4P
III	Outer*	m	m, p		s, m	c, s, p′	c, 3p′, p	c	c, 3P	
	Inner		3s, P, m, s		H	P	c, 3P	P	3P	
IV	Outer		3s, p		fm, mH	2H				

*Armature tabulation does not include several hairlike processes in middle of protopodite.

The species name indicates the similarity between the new species from Eniwetok and *Caligus kalumai* from Hawaii.

Caligus alaihi, new species

FIGURES 26–28

MATERIAL.—1 female (holotype, USNM 120766) and 1 male (allotype, USNM 120767) from the buccal cavity of *Holocentrus sammara* (Forskål).

MEASUREMENTS (in mm).—1 female and 1 male:

	female	*male*
Total length, excluding caudal seta	2.77	2.07
Length of cephalothorax	1.55	1.21
Width of cephalothorax	1.53	1.12
Length of genital segment	0.65	0.40
Width of genital segment	0.68	0.36
Length of abdomen	0.34	0.32

DESCRIPTION.—Female cephalothorax (fig. 26*a*) ovoid, consisting of cephalon, maxilliped bearing and first 3 pedigerous segments. Frontal region approximately one-seventh the total length of cephalothorax, with fine membrane along anterior edge. Lunules (fig. 26*g*) distinct, extending posteriorly, on ventral surface, past junction of frontal region and remaining cephalothorax. Lateral margin of cephalothorax flatly convex although slightly irregular, with slight indentation anteriorly. Lateral ventral surface bearing 2 narrow membranes, first extending laterally, second medially, on ventral surface. Small, cup-shaped depression present in dorsal posterior lateral surface, with single, hairlike process arising from middle of cup. Posterior sinus irregularly U-shaped, with membrane along outer lateral surface. Median posterior surface extending posteriorly slightly past lateral posterior surfaces, overlapping anterior end of free fourth pedigerous segment. Major dorsal cephalothoracic grooves forming irregular H, anterior legs terminating well posterior to ocular region. Ocular region distinct, in anterior third of cephalothorax.

Female free fourth pedigerous segment short, length slightly more than half the width; segment widest medially, in region of fourth leg attachment. Segment distinct from genital segment ventrally, fused dorsally. Genital segment (fig. 26*c*) of general apple shape from dorsal viewpoint, anterior end narrowest. Fifth legs (fig. 28*h*) arising from posterior lateral surface, consisting of 2 setule-bearing nodules, anteriormost with single, lightly plumose setule, posterior with 3 lightly plumose setules.

Female abdomen 1-segmented, distinct from genital segment, lateral margins essentially parallel except at constricted anterior end; posterior surface angular, forming attachment surface for caudal rami, median posterior surface bilobed. Caudal rami (fig. 26*f*) constricted proximally, otherwise subrectangular, distal surface with 3 plumose setae and 1 plumose setule, on inner edge, distal outer surface with 2 plumose setules; distal half of inner surface plumose.

Male cephalothorax (fig. 26*b*) and free fourth pedigerous segment similar to that of female. Genital segment (fig. 26*d*) of general barrel

shape, fifth legs (fig. 28*g*) situated on posterior lateral surface, consisting of 2 setule-bearing nodules, anteriormost with single plumose setule, posterior with 2 plumose setules; sixth legs (fig. 28*g*) situated on posterior surface, adjacent to junction of genital segment and abdomen, consisting of nodule bearing 3 plumose setules. Abdomen

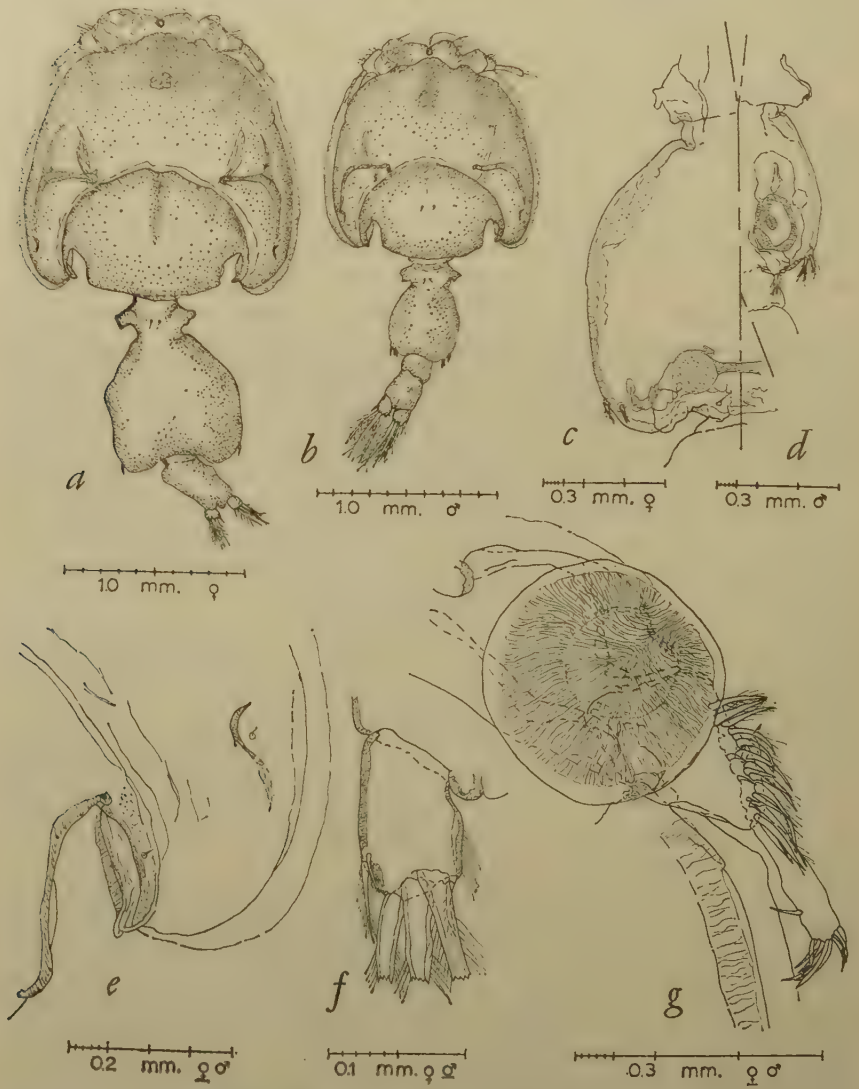

FIGURE 26.—*Caligus alaihi*, new species, dorsal views: *a*, female; *b*, male; *e*, posterior cephalothoracic sinus. Ventral views: *c*, female fourth pedigerous and genital segments; *d*, male fourth pedigerous, genital, and first abdominal segments; *f*, right caudal ramus; *g*, left lunule and antennule.

2-segmented, distinct from genital segment dorsally, indistinctly separable ventrally. First segment short, slightly more than half the length of second, lateral margins flatly convex; second segment constricted anteriorly, margins parallel posterior to constriction, posterior surface angular, as in female. Caudal rami as in female.

Female and male antennule (fig. 26*g*) 2-segmented, attached to both lateral ventral surface of frontal region and lateral anterior ventral surface of cephalothorax. First segment broad proximally, tapered to narrow distal end, anterior and ventral anterior surface with approximately 20 naked and lightly plumose setae and setules. Second

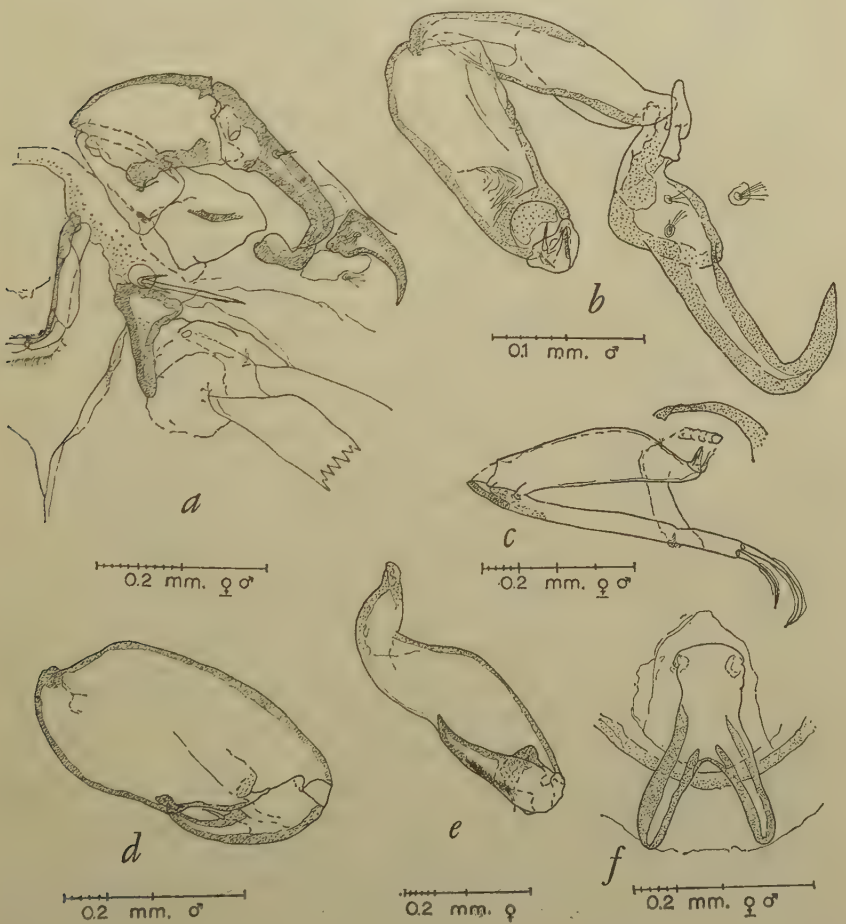

FIGURE 27.—*Caligus alaihi*, new species, ventral views: *a*, female oral region, showing antenna, mouth cone, mandible, maxillule, maxilla base (ma–2), postantennal, and postoral processes; *b*, male right antenna and postantennal process; *c*, right maxilla; *d*, male right maxilliped; *e*, female right maxilliped; *f*, sternal furca.

segment rodlike, approximately four-fifths the length of first segment, posterior surface with single naked setule distally, distal surface with 12 naked setae and setules. Female antenna (fig. 27*a*) 3-segmented, situated posterior and medial to antennule base. First segment short, squat, outline subtriangular. Second segment subrectangular; third segment and incompletely fused terminal process clawlike, with subconical accessory process proximally, setule-like, accessory process medially, at indistinct division between segment and terminal process. Male antenna (fig. 27*b*) 3-segmented, situated posterior to antennule base. First segment elongate, fused proximally with cephalothorax, angled ventrally toward distal end. Second segment well developed, broader proximally than distally, with adhesion pad on distal half of inner surface. Third segment fused with short, bifurcate terminal process, tines of terminal process pointed; setule-like accessory process present, arising just proximal to terminal process.

Female and male mandible (fig. 27*a*) rodlike, 4-parted, distalmost part curved inward, flattened, inner surface with 12 denticulations. Female postantennal process (fig. 27*a*) situated lateral and slightly posterior to antenna base, consisting of short, clawlike projection and 3 nodules, first 2 on base of projection, third slightly posterior to base, all 3 with several hairlike processes. Male postantennal process (fig. 27*b*) as in female except clawlike projection much longer. Female postoral process (fig. 27*a*) spinelike, situated immediately posterior to maxillule, spine projecting from middle of base, distal end rounded. Male postoral process as in female except spine projecting from outer portion of base. Female and male maxillule (fig. 27*a*) nodular, situated lateral and slightly posterior to mandible base, nodule bearing 2 short and 1 long, seta-like processes. Female and male maxilla (fig. 27*c*) 2-segmented, located posterior and lateral to postoral process; both segments slender although first approximately two and one-half times the diameter of second, length slightly more than four-fifths that of second. Second segment rodlike, with small flapshaped membrane on distal third of outer surface, bearing 2 saberlike terminal processes, innermost longer than outer, both with fine membrane along outer and inner margins.

Female maxilliped (fig. 27*c*) 2-segmented, situated posterior and slightly medial to maxilla base. First segment strongly developed, with slightly recurved proximal region terminating in knoblike proximal end; inner medial surface with small, shelflike projection (not shown on figure) receiving distal end of terminal process of second segment when segment flexed. Second segment distinct from clawlike terminal process, bearing setule-like accessory process on distal inner surface. Male maxilliped (fig. 27*d*) similar to that of female except first segment more strongly developed and recurved proximal end

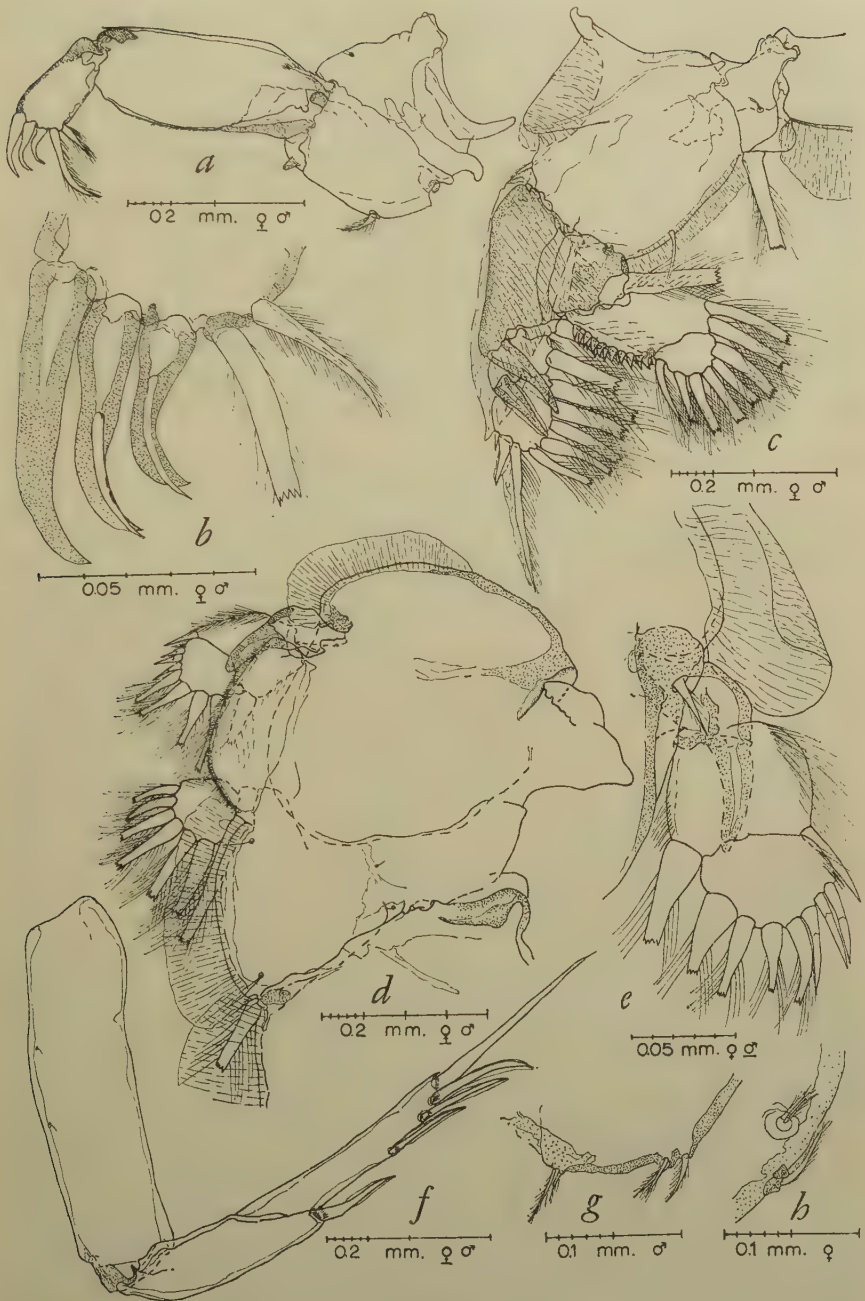

FIGURE 28.—*Caligus alaihi*, new species, right thoracic legs, anterior views: *a*, first; *b*, distal region of second segment of exopodite of first; *c*, second; *d*, third; *e*, exopodite of third (posterior view); *f*, fourth. Legs, ventral views: *g*, male left fifth and sixth; *h*, female right fifth.

reduced. Female and male sternal furca (fig. 27*f*) well developed, Y-shaped, distal ends of rami rounded.

Thoracic legs I–III biramous although endopodite of first leg rudimentary; fourth thoracic leg unirmaous, 3-segmented. For nature and armature of thoracic legs, see figures 28*a–f* and table 11.

Discussion.—The diagnostic characteristic of *Caligus alaihi* is the combination of a 2-segmented abdomen on the male, denticulations on the second segment of the endopodite of the second thoracic leg (but not on the first segment), and the presence of only 1 plumose seta on the inner surface of the second segment of the exopodite of the first thoracic leg. Of these three, the most uncommonly found feature in other members of the genus is the presence of a single seta on the inner surface of the second segment of the exopodite of

Table 11.—*Armature of thoracic legs I–IV of the female and male of* Caligus alaihi, *new species*

Leg	Surface	Interpodal Plate	Protopodite		Exopodite			Endopodite		
			1	2	1	2	3	1	2	3
I	Outer		ss, p		rh	3H, P				
	Inner		p		c	p				
II	Outer	m		m, p	m, mH	mH	rh, mh, Q	c	D	3P
	Inner		s, P	m, s	c, P	c, P	5P	P	c, 2P	3P
III	Outer	m	r, m, p			c, p′	c, 3p′, P	c	c, 3P	
	Inner		3s,P,m,s		H	c, P	3P	P	3P	
IV	Outer		2s, p		fm, mH	4fm, 3mH, H				

the first thoracic leg. This feature, however, is found in at least one other species, *Caligus pagrosomi* Yamaguti, 1939. *Caligus alaihi* can be most readily distinguished from *C. pagrosomi* by the presence of denticulations on the second segment of the endopodite of the second thoracic leg, in contrast to the plumosities presumed to be found on the same segment of *C. pagrosomi*. (Yamaguti, 1939, does not provide a description of the second thoracic leg of *C. pagrosomi* but does indicate, p. 445, that the species is very similar to *C. epinepheli* Yamaguti, 1936, which does possess plumosities on the second segment of the endopodite of the second thoracic leg.) *Caligus alaihi* can also be distinguished from *C. pagrosomi* by the apparent length of the abdomen of the female, that of *C. pagrosomi* being approximately twice the length of that of *C. alaihi*. This characteristic, however, should be used with some reservation as the variability (or potential variation)

is not discernable from the single female in the collection of copepods from Eniwetok fishes.

The species name is derived from the Hawaiian name, "alaihi," for several of the holocentrid fishes, the family to which the host of this copepod belongs.

Caligus laticaudus Shiino

FIGURES 29, 30

Caligus laticaudus Shiino, 1960, p. 482, figs. 5, 6.—Pillai, 1961, p. 91, fig. 3.—Yamaguti, 1963, p. 55, pl. 68, fig. 4.

HOSTS AND DISTRIBUTION.—3 host records:

locality	*host*	*reference*
Japan	*Pagrosomus major*	Shiino, 1960
South India	*Polynemus heptadactylus*	
	Rhabdosargus sarba	Pillai, 1961

MATERIAL.—1 female (USNM 120769) from the external surface of *Acanthurus olivaceous* Bloch and Schneider.

MEASUREMENTS (in mm).—1 female:

Total length, excluding caudal setae	2.46
Length of cephalothorax	1.24
Width of cephalothorax	1.21
Length of genital segment	0.56
Width of genital segment	0.72
Length of abdomen	0.41
Length of egg strings (not present, condition suggests specimen an immature adult)	

DESCRIPTION (female only).—Cephalothorax (fig. 29*a*) ovoid, consisting of cephalon, maxilliped-bearing and first 3 pedigerous segments. Frontal region approximately one-ninth the length of cephalothorax, with narrow membrane along anterior margin. Lunules (fig. 29*e*) distinct, extending posteriorly, on ventral surface, to posterior portion of frontal region, of relatively simple construction in comparison with those of *Caligus coryphaenae*. Division between frontal region and rest of cephalothorax distinct. Lateral margin of cephalothorax flatly convex, bearing single, narrow membrane extending laterally; posterior lateral surface lappet-shaped, with small, cupshaped indentation bearing 2 clusters of hairlike processes. Posterior sinus (fig. 29*c*) U-shaped, with membrane along outer margin. Median posterior surface of cephalothorax extending slightly past lateral posterior surfaces, posterior margin irregular on single specimen in collection. Major dorsal cephalothoracic grooves forming irregular H, anterior legs of H terminating well posterior to ocular region. Ocular region distinct, in anterior third of cephalothorax.

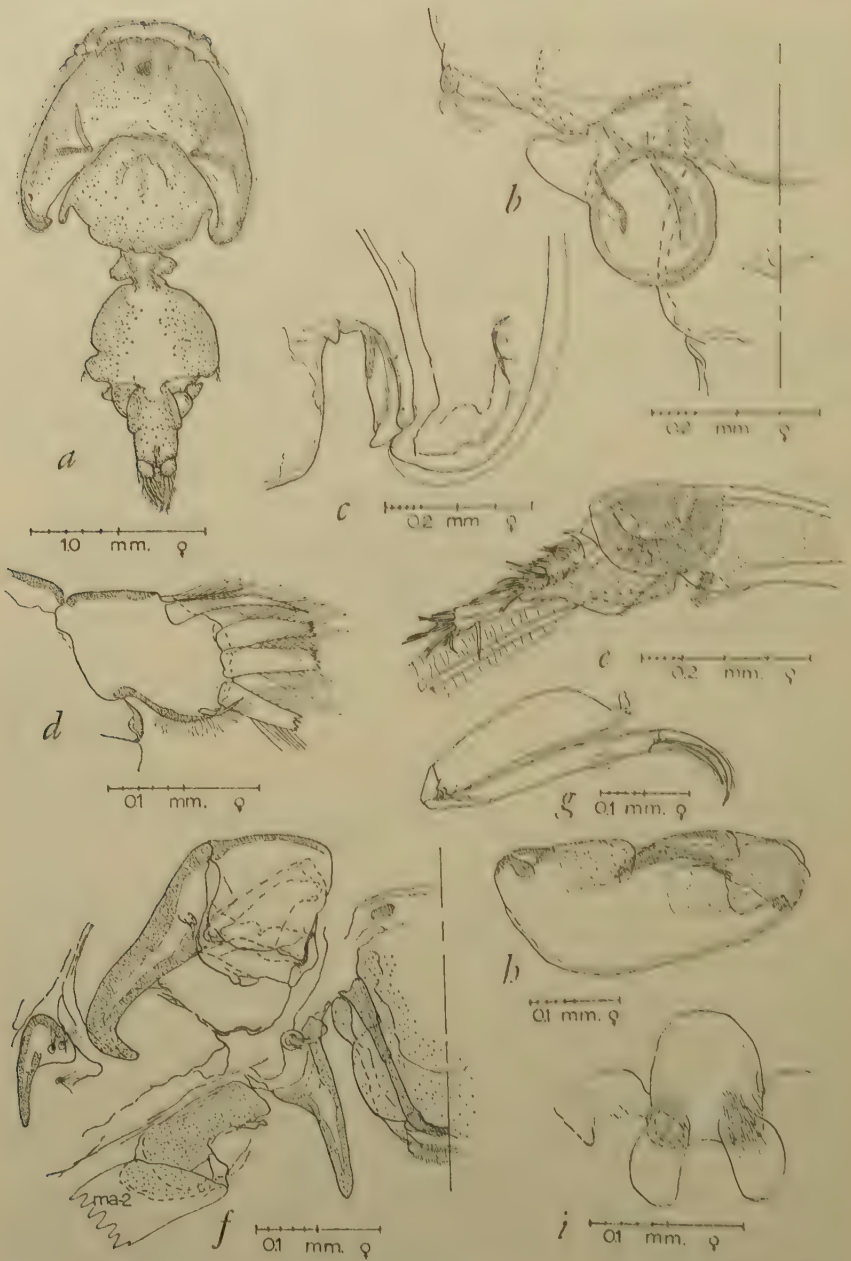

FIGURE 29.—*Caligus laticaudus* Shiino, 1960, female: *a*, dorsal view; *d*, right caudal ramus, same view. Ventral views: *b*, posterior region of genital segment and adjacent surface of abdomen, showing fifth leg and attached spermatophore; *c*, posterior cephalothoracic sinus; *e*, left lunule and antennule; *f*, oral region, showing antenna, mouth cone, mandible, maxillule, maxilla base (ma–2), postantennal, and postoral processes; *g*, right maxilla; *h*, left maxilliped; *i*, sternal furca.

Free fourth pedigerous segment distinct from cephalothorax, indistinctly separable from genital segment; segment widest medially, at junction with fourth thoracic legs, tapered anteriorly and posteriorly. Genital segment (fig. 29*b*) subovoid, posterior region irregular in single available specimen. Fifth legs (fig. 30*g*) situated on posterior lateral surface of segment, consisting of node bearing 2 or 3 plumose setules (2 present on specimen, indication of additional broken setule) and nodule bearing single plumose setule (= sixth leg of Shiino, 1960, p. 485).

Abdomen indistinctly 2-segmented, distinct from genital segment ventrally, indistinctly separable dorsally. First segment with flatly convex lateral surfaces, second tapered slightly to posterior surface. Division between segments consisting of break in cuticle of lateral regions only, muscle-segment associations not distinct enough to indicate segmentation. Caudal rami subpalmate, bearing 3 plumose setae and 1 plumose setule distally, plumose seta and setule present on distal half of outer lateral surface; distal half of inner surface plumose.

Antennule (fig. 29*e*) 2-segmented, attached to anterior lateral ventral surface of cephalothorax and adjacent surface of frontal region. First segment approximately twice the length of second, broad proximally, tapered distally; anterior surface sharply angled distally. First segment bearing approximately 22 lightly plumose and naked setae and setules. Second segment rodlike, bearing single naked setule from distal half of posterior surface, 11 naked setae and setules (including 1 bifurcate seta) distally. Antenna (fig. 29*f*) 3-segmented, situated posterior and slightly medial to antennule base. First segment squat, subtriangular from ventral viewpoint; second segment well developed, broad proximally, tapered slightly to distal end. Third segment and terminal process fused, with falciform outline; single, setule-like accessory process present on node at proximal end of fused segment and terminal process.

Mandible (fig. 29*f*) rodlike, 4-parted, distalmost part curved inward, flattened, inner surface with 12 denticulations. Postantennal process (fig. 29*f*) situated lateral and slightly posterior to antenna base, consisting of spikelike projection and 3 nodules bearing several hairlike processes. Projection arising from small, subtriangular, heavily sclerotized plate, plate also bearing 2 of 3 nodules, third nodule immediately posterior to plate. Postoral process (fig 29*f*) spinelike, curving outward slightly. Maxillule (fig. 29*f*) nodular, situated immediately anterior to postoral process, nodule bearing 1 long, 2 short, naked seta-like processes. Maxilla (fig. 29*g*) 2-segmented, situated immediately posterior and slightly lateral to postoral process. First segment approximately nine-tenths the length of second, second elongate, with

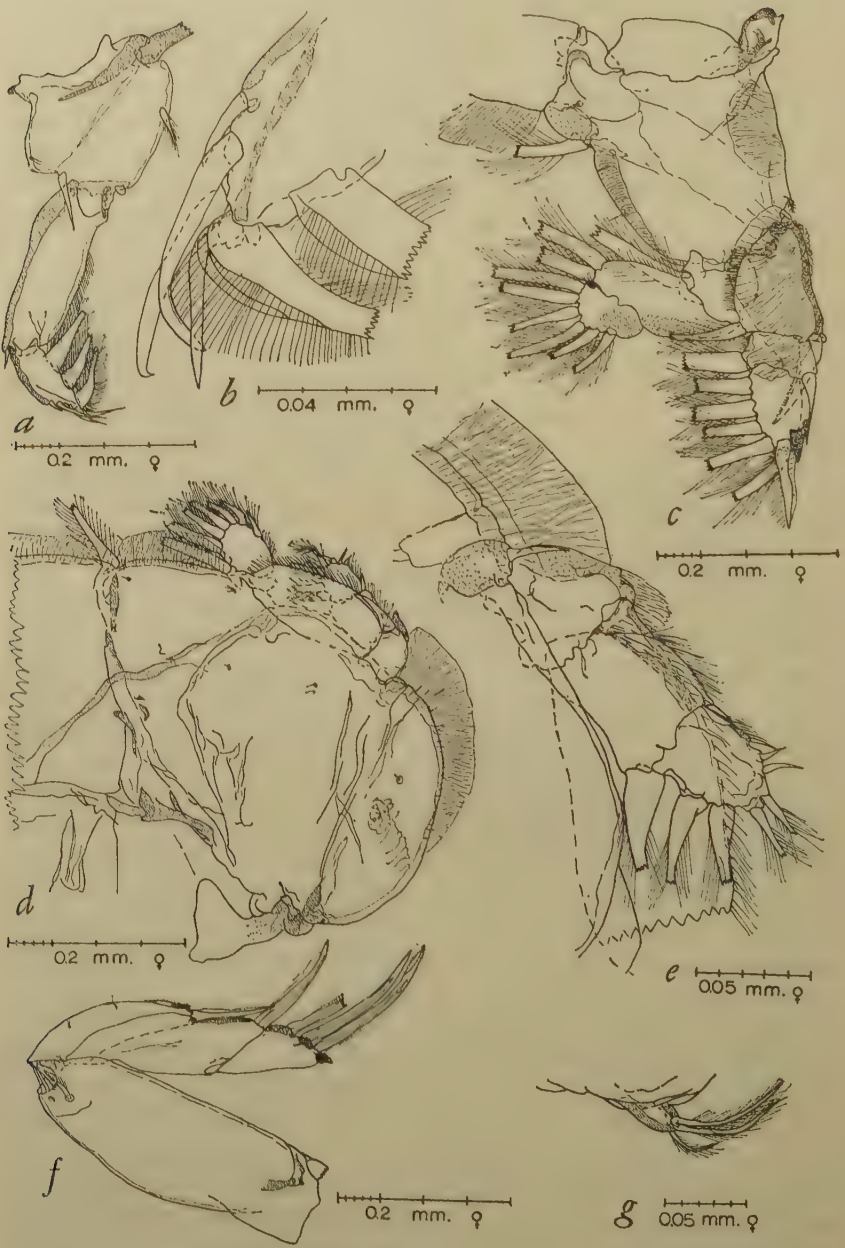

FIGURE 30.—*Caligus laticaudus* Shiino, 1960, female, right thoracic legs: *a*, first, anterior view; *b*, distal region of second segment of exopodite of first, anterior view; *c*, second, posterior view; *d*, third, anterior view; *e*, exopodite of third, posterior view; *f*, fourth, posterior view. Right fifth leg: *g*, ventral view.

fine membrane on distal half of outer surface, distal surface bearing 2 saber-shaped processes, innermost approximately one and one-fourth times the length of outermost, both fringed with fine membrane.

Maxilliped (fig. 20*h*) 2-segmented, situated posterior and slightly medial to maxilla base. First segment strongly developed, irregular in outline; widest medially, proximal end narrow, distal approximately half the greatest width; segment with socket-like shelf on medial inner surface, receiving distal end of second segment terminal process when segment flexed. Second segment distinct from clawlike terminal process, bearing setule-like accessory process on distal inner surface. Sternal furca (fig. 29*i*) situated between and slightly posterior to maxilliped bases, bifurcations flattened anteroposteriorly, lobate in outline.

TABLE 12.—*Armature of thoracic legs I–IV of the female of* Caligus laticaudus *Shiino, 1960*

Leg	Surface	Interpodal Plate	Protopodite		Exopodite			Endopodite		
			1	2	1	2	3	1	2	3
I	Outer		ss, p		rh	h, 2II, p′				
	Inner		p		c	3P				
II	Outer	m		m, p	m, dmH	H	h, H, Q		c	c, P
	Inner		s, P	m, s,	c, P	c, P	5P	P	c, 2P	c, 3P
III	Outer	m	m, P		m, s	c, p′	c, 3p′	c	c, 3P	
	Inner		P, s, m, s		H	P	4P	P	3P	
IV	Outer		p		fm, mH	fm, mH	fm, 3mH			

Thoracic legs I–III biramous although endopodite strongly reduced in first leg; fourth thoracic leg uniramous, 4-segmented. For details of legs and armature, see figures 30*a–f* and table 12.

DISCUSSSION.—The Eniwetok specimen differs from Shiino's original description in several points:

1. There is a setule on the inner surface of the protopodite of the first thoracic leg that is not listed or figured in Shiino's publication.

2. The sternal furca appears broader than that shown by Shiino for *C. laticaudus* although the angle from which the drawing was made may at least partially explain this.

3. The total length of the Eniwetok specimen is smaller than that listed by Shiino (3.51 mm) although Pillai (1961) lists 2.6 mm as the length of his female specimen(s?). The difference in length between the Eniwetok specimen and Shiino's is presumed to be, at least in part, due to the possible immature adult condition of the Eniwetok specimen.

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U.S. GOVERNMENT PRINTING OFFICE: 1968